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Monthly Message

Somewhat over ten years ago Dr. Richard L. Meiling, Chairman of the Armed Forces Medical Policy Council, conceived the idea of establishing the *United States Armed Forces Medical Journal*. Its inception and publication were due to him. He deserves the thanks of many for his vision and during this period the *Journal* has fulfilled a great need for the Services. With the advent of many new medical journals and medical type periodicals during this period, however, the necessity for the continuance of the *Armed Forces Medical Journal* has been increasingly questioned. On the other hand there have been many highly complimentary letters urging its continuance. With the growing complexities of administration and increasing competition and demand for Department of Defense funds, the decision has been made to discontinue the *Journal* with this issue. This question has been much to the fore over the past year, and it is with great regret that the Department of Defense has finally come to this decision.

Over sixty-five years ago the Association of Military Surgeons was established by Act of Congress to promote better understanding between the then two Services. For many years the Association has published *Military Medicine*. This journal includes in its reports not only the activities of the Army, Navy, Air Force, and Marines, but also the Public Health Service and Veterans Administration. Furthermore, it affords an excellent medium for articles dealing with historical and military aspects of medicine and surgery. It is noted that in its constitution there is a provision for a Publication Committee, similar to an editorial board. This Committee does not exist at present, but if and when established, should further strengthen *Military Medicine* and provide an active advisory editorial board. It is urged and hoped that by increasing support, *Military Medicine* may fill the place which the *Armed Forces Medical Journal* has so happily and successfully occupied during the past decade.

Personally I am sorry that this must be and I shall miss this opportunity of continued "personal" and privileged communication with all of you.

FRANK B. BERRY, M.D.
Assistant Secretary of Defense
(Health and Medical)

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NOTICE TO READERS

The Editors regret to announce that the *United States Armed Forces Medical Journal* ceases publication with this issue, completing volume 11.

UNITED STATES
Armed Forces Medical Journal

Functions of Military Medical Statistics

HENRIK M. C. LUYKX, D.SC.

EVEN A TINY FRACTION of hundreds of millions of dollars can be a sizable sum. The effort that goes into the collection of medical statistics should, of course, be only a small part of the total medical effort, and indeed it is. Let there be no confusion between *statistics* and *paper work*. The burden of paper work has been much discussed and often exaggerated, but it is a necessary part of proper medical practice and of management in a large enterprise such as the federal government. Statistical effort is only a small part of the total paper work; it consists primarily of assembling and using data that are a by-product of necessary professional and administrative procedures. The cost of military medical statistics, therefore, consists of only that effort that would not be expended if no statistical analysis were done. But even this represents a significant number of dollars, and it is appropriate to inquire what it is intended to accomplish.

In a competitive business, the expenditure for statistics takes care of itself. If the use of certain data produces an increase in income or a decrease in operating cost greater than the cost of gathering the statistics, then that effort is justified.

That statistics in government is essential is accepted historically (the word itself has "state" as its root). The general need for statistics in management of huge medical systems is therefore not questioned. Furthermore, the history of medical science gives ample evidence of the significant contributions of statistics as a specialized discipline. The question, really, is how far should one go in expenditure for medical statistics? If we ask, "What is the value of this effort?" we find that the dollar sign may lose its meaning—unless there is some way of evaluating the cost of a human life, of health and morale in a fighting force, or of the welfare and safety of the nation. The fol-

From the Biometrics Division, Office of the Surgeon General, Department of the Air Force, Washington, D.C.

lowing is a review of what has been done or can be done with military medical statistics—or what cannot be done without statistics.

EVALUATING THE IMPACT OF HEALTH AND MEDICAL FACTORS

Effective Strength

In order to determine the fighting effectiveness of a military machine, or to maintain this at its maximum, one must have knowledge of the medical problems that impinge upon it.

First, there is the impact of illness itself. It is necessary to know the loss in strength chargeable to limited illness, to permanent impairment, or to death, and the cause of specific diseases. Medical causes of noneffectiveness are evaluated by comparing the numbers of man-days spent in a "sick" status for different specific conditions. For example, in round numbers, 1 person out of every 3 or 4 will be excused from duty because of illness during a normal year, and on a given day 1 out of 100 persons drawing military pay will be sick in bed. Statistics also show us that accidents, particularly those due to motor vehicles and aircraft, have the greatest impact on the effective strength of the military services. In one of the military branches two thirds of the persons permanently lost from the service (by death or disability separation) owe their fate to accidents. In relation to special groups, such as flyers, the extent of illness is an important factor in determining military capability.

Preventable Diseases

For preventable diseases, it is necessary to count the numbers of cases, with respect to exposure to risk, geographic area, seasonal factors, and other environmental conditions, in order to identify problems to be managed in preventive medicine. In military operations it is necessary that such problems be recognized immediately, so that specific and perhaps drastic action may be taken as needed. Measures of incidence are computed on a current basis for this purpose. Incidence rates are also used to determine the need for, and guide the application of, immunization policies, accident prevention programs, and so on.

A military medical reporting system lends itself to a program of medical surveillance that is not possible elsewhere. Specific directives can give a fair guarantee that isolated occurrences of important communicable diseases do not go unreported. If encountered occasionally,

cases of amebiasis, scarlet fever, or malaria, for example, might not cause concern; but if the occurrence were simultaneous in many places, that fact would be of great military and national importance.

Physical Requirements and Standards

Statistics are required to help determine and to evaluate physical requirements and health standards of military personnel. Manpower resources, especially in time of war, are affected markedly by the levels at which minimum physical requirements are set. A given departure from the normal, in visual acuity for example, may be of no consequence in civil life, but may constitute a definite impairment in military service; and within the military service limiting standards are quite different in different occupations, as in flyers versus ground personnel. Heights, weights, blood pressures, and predispositions such as allergies are statistically important in order to measure the quantitative effect of limitations or changes in physical standards. A tremendous fund of statistics comes from the physical examination of selective service registrants, performed at military induction stations. These constitute a source—probably unmatched in reliability or extent—of information on normal distributions of physical or physiologic factors, and of frequency of physical impairments. Such information is necessary to the military in order to evaluate its manpower resources; but at the same time it is of great value in civilian programs dealing with handicapping conditions, rehabilitation, and physical fitness.

Special Stresses of Military Operations

Special stresses imposed by military operations must be observed statistically, in relation to presumably healthy and normal persons and to predisposing pathogenic factors. Effects of high atmospheric pressure, as in divers, have obviously important implications and show great variation between persons. Effects of low pressure, as in aviators, have similar implications and in addition need to be related to clinical or subclinical factors, such as vasomotor lability or sickle cell trait.

MANAGEMENT OF MEDICAL SERVICES

In management, there are at least 2 levels of administration where statistics play a part: (1) in the local operation of a hospital, let us say; and (2) at a headquarters where management policies are determined. In the military services there are additional levels, such as

intermediate commands, or the supra-headquarters level, as in justifying funds before Congress or the Bureau of the Budget. Management statistics of the various types to be described are used at various levels under different circumstances, as dictated by administrative policies.

Workload Data

The primary objective of efficiency in management is to conserve resources, or simply, to save money. Current and accurate knowledge of workloads permits economical allocation of medical service personnel, supplies, and facilities, without endangering the quality of medical care. The corollary is that if resources are not properly managed and are thus depleted faster than expected, the quality of the medical service will suffer. Measures of workload, therefore, are necessary at the local level in order to provide for anticipated immediate needs, and at the headquarters level, to forecast long-range needs. At both levels, workload statistics are of historical importance, in order to gage how effectively staff, supplies, and facilities were used.

The commonest measure of workload in the military medical services is the number of beds occupied by patients. Statistics on bed occupancy are more meaningful when refined as to category of patient (military, military dependent, civilian), nature of the disease (i.e., specialty requirement), extent of daily or seasonal fluctuations, and so on. Other measures, sometimes used in combination with bed occupancy, provide workload estimates of greater usefulness. These are numbers of admissions, also refined as to category of patient, nature of the illness, numbers of outpatient visits, prescriptions filled, special clinic services given, physical examinations performed, immunizations given, and similar items.

For example, it is a common observation, in the experience of the military services, that admission rates are decreasing from year to year. It is also noted that such rates for recruits, or personnel with a short period of service, are higher than for personnel with longer military duty. Likewise, it has been observed in some instances that enlisted men have higher admission rates than officers, or that women have higher rates than men. These items are important in estimating future requirements for facilities, medical personnel, and supplies, where plans are based on known future proportions of officers, or of women, for example, in the armed services.

Another important factor in planning is the upward trend in outpatient visit rates in the military establishment. This phenomenon is complementary to the downward trend in admission rates; clinic

services undoubtedly contribute to the decreased need for hospitalization. Such a change in the character of medical care has a very significant bearing on the facilities that must be planned for the future.

Workload measures such as those mentioned, properly refined and interpreted, are used to indicate the requirements for medical officers, nurses, and other medical service personnel, with regard to specialties and levels of proficiency. They are also used in determining needs for medical supplies and equipment and for designation of optimum bed capacities and outpatient facilities. In medical service operations, these constitute guides for allocation of staff on hand, for making supplies, or funds for supplies, available, and for placing latent bed capacity in operation. For future planning, the same types of statistics are used to develop trends and to estimate forthcoming needs. The farther into the future the estimate, the greater the need for refinement of the data and careful interpretation of their meaning.

Population Data (Strengths)

Statistics of populations at risk, or "strengths served," are used as denominators for computing rates, specific for location, certain categories of patients, age, and so on. Workload experience must be expressed in quantities per standard unit of population, in order to have any value for planning purposes. The prediction of future populations is itself a statistical task of some significance. In order to plan for medical services at a particular location, one must know not only the number of persons to be stationed there but also, for example, the proportion of flying officers, or the proportion with families and the age distribution of their children.

At present there is a new and particular need for data about the population served under the Medicare program, because there is no lengthy period of experience from which to draw statistics. Even though only very general information is available about the characteristics of dependents and other nonmilitary persons, their diseases and their medical care are documented as faithfully as those of military patients. From these records, by means of appropriate statistical analysis, a great deal can be learned regarding trends and other factors for planning future needs.

New Management Technics

In the management of the military medical services there is an unusual added opportunity to develop new statistical tools, as well as to explore new methods of collecting, processing, and analyzing data.

It may be said that one does not collect statistics for the purpose of learning how to do so; but without collecting them one cannot learn how. It seems appropriate, therefore, to include among the functions of military medical statistics the scientific development of this discipline. Modern devices for recording and transmitting data, and electronic machines for making tabulations and statistical computations, should be explored for their application to the field of medicine, particularly because the military services have unique requirements and provide unique opportunities for advances in biometric methodology.

CONTRIBUTION TO MEDICAL KNOWLEDGE

Another objective of military medical statistics is a more general one. The data can and should be used in the general advancement of medical science. This is a contribution to the welfare of the nation and a proper application of the taxpayer's dollar. In a way, it is by far the most important use of clinical data, even though it is sometimes more difficult to describe the value of the product or to show how this is a profitable return on the investment of military effort.

For many of the serious medical problems of today, there are no large quantities of data from the population at large because no single source of information covers a large population segment. Except for special problems managed under government sponsorship, data from a variety of sources frequently lack sufficient uniformity to permit summation; this is part of the reason why mechanisms for assembling diagnostic data from independent sources are not common. One is limited by the lack of uniformity not only in observing and recording disease phenomena, but also in diagnostic classification and in recording relevant demographic data.

Epidemiology of Disease

The use of statistics in the development of medical knowledge has been ably summarized by Ingraham,[1] who places "the epidemiological approach, with its heavy reliance on statistical compilation and analysis of events observed in human populations" on a par with animal experimentation in the laboratory and clinical investigation in the ward. In the light of such a statement, progress in medical science then depends in significant part on how extensively and how wisely this resource of recorded data, so abundant in the military services, is used.

History tells of great contributions to medicine by the military

medical services. The works of William Beaumont, Walter Reed, William Crawford Gorgas, and many other military surgeons stand as landmarks in the progress of modern civilization. In some instances the impetus came from the need to solve a military problem, in others it came from the physician's dedication to his craft wherever he might ply it. But it is unquestioned that advances in gastroenterology and in the control of yellow fever were of benefit not solely to the military.

In the nonmilitary history of medicine, a catalog of medical problems approached, and solved, by statistical epidemiology would be too extensive to include in these pages. Outstanding examples known to every one are cholera (by Snow), malaria (by Ross), and pellagra (by Goldberger). The relationship between rheumatic fever and the hemolytic streptococcus, between scurvy and vitamin C, between fluorine and dental caries, between rubella and fetal defects, between roentgen rays and leukemia, are also examples of problems that have depended, either entirely or to a great extent, on statistical analysis for their solution. In some instances, as in cholera, the statistical approach was crude but effective under the circumstances. In problems such as poliomyelitis vaccine, or smoking and lung cancer, a mere adding of numbers and comparing of percentages are not enough. Here biometry as a science has been applied in all its sophistication, with concurrent difficulty in differentiating, to everyone's satisfaction, between valid and spurious conclusions.

An example of the contribution of military medical statistics to significant medical problems is the demonstration of the relationship of serum hepatitis to jaundice and yellow fever vaccination. Also, large-scale studies on the epidemiology of the common cold have been conducted at military installations because nowhere else has such a large controlled population been available.

For influenza, as another example, military records give a clear picture of the worldwide spread of this disease and of variations in the virulence of different epidemics in relation to specific geographic areas and season of the year. In the epidemics of 1957, cases among military personnel numbered well over 100,000; duration of illness in each case was generally a matter of a few days; and deaths attributable to influenza could virtually be counted on one's fingers. The fatal character of this disease has, therefore, been practically nil in recent experience, as compared with the 1918 pandemic, when fatalities (primarily a result of complicating pneumonia) occurred in terrifying proportions.

Thought should be given briefly to the unsolved problems in medicine that appear frequently in the news. A recent compilation [2] estimates the annual dollar cost of the following list of diseases, in

economic loss to the nation, including the direct cost of medical services.

Arteriosclerosis	$1, 100, 000, 000
Cancer	600, 000, 000
Mental diseases	4, 000, 000, 000
Arthritis and rheumatism	1, 500, 000, 000
Eye diseases and blindness	100, 000, 000
Cerebral palsy	200, 000, 000
Multiple sclerosis	200, 000, 000
Muscular dystrophy	(200, 000, 000)*
Epilepsy	(1, 100, 000, 000)*
Parkinsonism	(1, 100, 000, 000)*
	$10, 000, 000, 000

*Estimated by the present writer (from the same source).

This round number total is, of course, a very rough estimate. It is primarily intended to be impressive, and it is. If application of military medical statistics to the epidemiologic study of these problems could reduce this cost by $\frac{1}{100}$ of 1 percent, it would be a saving of $1,000,000. This would pay many times over for the cost of doing something extra with those medical data now being collected as a necessary part of our military operations. Diseases of this kind are observed in large numbers in military hospitals, or among dependents of the military, who in many respects are not different from the national population as a whole and whose records contain demographic and other data not collected in such quantities anywhere else.

Special Stresses of Military Life

Of more specific interest to the military as well as to the nation are problems relating to the special stresses of military service as an occupation, such as field combat, submarine conditions, flying, and high altitude. For example, man has learned to control his physiologic and psychologic environment to the extent that he can navigate the atmosphere to the threshold of space or can circle the globe confined in a submarine. Although these are perhaps primarily subjects for laboratory investigation, statistics are often required to identify such problems and to evaluate the results of research when applied to man. In medical research the importance of statistical technics in experimental design and in the analysis of observations is generally well recognized.

Evaluation of Therapeutic Measures

Statistical analysis is also an essential tool for evaluating therapeutic measures, or for gaining prognostic knowledge. Herniated nucleus

pulposus and cranial injury are examples; the military establishments are in a uniquely convenient position to collect meaningful statistics for guidance in the management of these conditions. Interest in a particular disease, however, is not the exclusive property of the military, and knowledge regarding it is of benefit to everyone. The statistical technics of follow-up studies are particularly applicable here, and it is only by means of record systems such as those of the military that these technics can be used effectively. Many special category groups, such as females, obstetric cases, and children of servicemen, provide data that cannot easily be accumulated elsewhere in the quantities required for fruitful investigation of their special problems. The value of analyses of such groups frequently lies in the fact that denominator populations (or "control" groups) are more readily defined.

Prevention of Illness

In the prevention of illness, the military services encounter problems that perhaps are not common to the civil population. But many problems, such as infectious hepatitis or motor vehicle accidents, are of great common concern. Here military medical statistics can provide data, not obtainable elsewhere, to help identify the pertinent factors in these causes of illness and thus suggest preventive measures. Furthermore, in a controlled population such as the military services, the opportunity is uniquely at hand for evaluating the results of prophylactic or other protective procedures.

Statistical Methodology

Another important contribution that can be made by the military medical services lies in the area of statistical methodology itself. Because of the size of the controlled population, and the extensiveness of the medical service systems, special attention can be given to problems of diagnostic nomenclature and classification, recording and indexing technics, methodology in processing and analyzing data, and philosophy of statistical reasoning. Observation of medical phenomena is itself a statistical problem. Variations introduced into a series of records, by differing diagnostic technics, by differences in subjective interpretations, and so on, when properly analyzed, can contribute to the general knowledge of biostatistics, applicable to all medical science.

COMMENT

It is seen that the foregoing does not deal with the functions of the statistician, but with those of statistics. That is to say, the writer

has attempted to summarize the reasons for collecting statistics, on the assumption that the data will be used appropriately and effectively. It should not be taken for granted that the latter comes about automatically. Misuse of statistics is a common target for the skeptical, but possible ineptness should not be construed as a reason for discarding the tool. On the contrary, awareness of the value of statistics as an implement should provide incentive toward enhancing the qualifications of the artisan.

In quality, military medical statistics probably constitute a body of medical data without rival in the world. Nowhere else are records collected from millions of patients, in hundreds of hospitals and dispensaries, with concurrent denominator data regarding the population served or at risk. And this is done in accordance with a uniform or coordinated set of directives regarding procedures for physical examinations, policy on therapy, preventive measures, hospital management, diagnostic classification, and recording of demographic characteristics.

Another feature of great significance is the fact that each diagnosis recorded in this system is one that has been made by a qualified physician. This is in contrast to many surveys of health and illness, which, although including large population segments, have as "diagnosis" only the statements made by patients or members of their households. Here, obtaining uniformity in diagnostic terminology and analyzing the effect of inconsistencies become statistical problems in themselves.

SUMMARY

Although the money spent on medical statistics is but a tiny part of the total military medical effort, it is a considerable sum. What are the functions that are served or can be served by medical data emanating from the military services? They are described under 3 major headings: (1) evaluating the impact of health and medical factors (impact on effective strength, preventable diseases, physical requirements and standards, special stresses of military operations); (2) management of the medical services (workload data, population data, new management technics); and (3) contribution to medical knowledge (epidemiology of disease, special stresses of military life, evaluation of therapeutic measures, prevention of illness, statistical methodology).

Military medical statistics provide a source of data not obtainable elsewhere in the world. They comprise records running into the millions, prepared under a coordinated system that provides a high degree of uniformity. They are also unique in that all cases carry a diagnosis

established by a qualified physician, in contradistinction to many large-scale surveys in other areas, which depend on nonmedical statements regarding illness. Full exploitation of this valuable source of medical data is urged.

ACKNOWLEDGMENT: In assembling the foregoing ideas, the use of information emanating from the annual reports of the Surgeons General of the Army, the Navy, and the Air Force, respectively, and from other sources [1-6] is gratefully acknowledged.

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INTELLECTUAL YARDSTICK

It would appear that the magnitude and importance of a new concept or idea is proportional to, and indeed may be measured by, the violence of the opposition which it engenders in the minds of contemporaries, for on the one hand we are all consciously or unconsciously conservative and resent any sudden disturbance of our intellectual status quo, while on the other hand few of us are free from jealousy of the man of original mind.—W. ARTHUR MACKEY: Three Great Scots. *A.M.A. Archives of Surgery*, January 1960.

Primary Endocardial Fibroelastosis

With Observations on Seasonal Incidence

CAPTAIN QUENTIN C. CASE, USAF, MC

A FREQUENT KILLER OF INFANTS, primary endocardial fibroelastosis (EFE) is receiving increasing recognition.[1-4] Rosahn[5] mentions an incidence of 1 to 3 percent of autopsies on children. Our knowledge of endocardial fibroelastosis is traceable to the early nineteenth century, when Kregzig[6] reportedly described scarring of the endocardium in support of his theory that fetal endocarditis is a cause of congenital heart disease. This theory held sway until 1941, when elaborating on concepts then developing in Europe, Gross[7] questioned the evidence for fetal endocarditis. Speaking of the endocardial scarring in cases of so-called fetal endocarditis, Gross said: "The valvular and parietal endocardial changes seen in these cases are better explained on the basis of a developmental defect, since they show no inflammatory residue."

The term "endocardial fibroelastosis" may have been introduced by Weinberg and Himmelfarb in 1943[8] and has been used to describe both the primary type and the type associated with certain other heart conditions.[1,2] In 1956 Andersen and Kelly[1,2] were able to collect from the literature 79 cases without associated cardiac malformations; to these they added 17 cases of their own.

PATHOLOGY AND CLINICAL FEATURES

Endocardial scarring without prominence of elastic tissue is found in certain collagen diseases,[9] cardiac carcinoid,[10] beriberi,[11] and other conditions.[12,13] Fibroelastic scarring is also an associated finding in a variety of diseases, including certain congenital heart lesions,[1] infantile myocardial infarction,[14] and diphtheria.[15]

From Milwaukee Children's Hospital and the Department of Pediatrics, Marquette University, Milwaukee, Wis. Captain Case is now assigned to U.S. Air Force Hospital, Whiteman Air Force Base, Mo.

Details of the pathology of primary EFE may be found elsewhere.[16-18] There is marked cardiac hypertrophy and dilatation, especially of the left heart. The endocardial and subendocardial layers of the left ventricle are much thickened by collagenous and elastic tissue. The layer of scarring continues some distance into the myocardial wall along the trabecular sinusoids. The papillary muscles are often severely involved, so that the chordae tendineae may appear to arise directly from the chamber wall. Some fibers reminiscent of the Purkinje system may be prominent at the junction of sclerotic and muscular tissue. Myocardial hypertrophy is apparent microscopically, and there is a paucity of inflammatory change. Less often a fibrin-like material [19] as well as reticulum [2] has been described in the sclerotic layer. Although valvular involvement has been observed,[17] it is not an essential of the primary disease.

The clinical pattern of primary EFE has been fairly well defined.[2,20,21] No important race or sex predominance has been noted. About one third of patients are said to have symptoms before 2 weeks of age, and two thirds before 6 months, over 90 percent of deaths occurring at less than 2 years of age.[3] Sudden death is frequent in primary EFE,[20] or there may be a varying historical pattern of failure to thrive, with or without episodes of respiratory distress, cyanosis, or congestive heart failure.

The patients are often fairly well developed and well nourished. Some degree of respiratory distress is typical and is often accompanied by cyanosis. Tachycardia is found at some time in most cases. Clinically detectable cardiac enlargement may be especially striking because it is usually unaccompanied by heart murmurs. Hepatomegaly is common.

Routine and special laboratory studies have shown no dependable pattern. Roentgenograms of the chest will almost always demonstrate cardiomegaly, especially left-sided enlargement. Enlargement of the left auricle may be a particularly helpful sign.[22] The electrocardiogram is not pathognomonic, but left ventricular hypertrophy patterns are common.[23]

CASE MATERIAL

By 1951, cases of primary EFE were being recognized at this children's hospital, and a review of previous autopsy material by Dr. Dann B. Claudon [24] revealed primary EFE in a number of cases originally diagnosed as idiopathic cardiac hypertrophy. From 1938 through 1958, including those cases originally diagnosed as idiopathic cardiac

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hypertrophy, 29 cases of primary EFE have been recognized by necropsy, the largest single group reported to the present time. During the last 8 years of this series, when the diagnosis was consistently recognized at necropsy, primary EFE was found in 20 of 730 autopsies, an incidence of almost 3 percent.

We have undertaken to review these 29 cases as well as some of the pertinent literature. In choosing these cases, other clinically significant cardiac lesions associated with EFE were eliminated. Only 1 significant extracardiac developmental defect—a cleft palate—was present among the 29 cases. In younger infants, minor degrees of patency of the ductus arteriosus found at autopsy were not considered significant lesions.

The 29 cases included 15 males and 14 females. Of these, 5 patients were Negro and 24 were white, figures approximating race distribution among admissions to this hospital. The age of the patients at the time of death was as follows:

Age (months)	*Number of patients*	*Age (months)*	*Number of patients*
<1	1	7–8	1
1–2	2	8–9	2
2–3	2	9–10	3
3–4	3	11–12	1
4–5	6	22–23	1
5–6	3	24–25	1
6–7	2	25–26	1

The youngest patient was 3 weeks and the oldest 25 months at time of death. The greatest incidence of death was during the fifth month of life, when about 20 percent of these patients died. Almost 90 percent of the deaths occurred before the age of 1 year.

The immunization history was known in 22 patients. Of these only 2 had had the basic diphtheria-pertussis-tetanus series, and 1 had had but a single diphtheria-pertussis injection.

The seasons during which these patients were born had the following striking distribution:

Season of birth	*Number of patients*
Summer	2
Autumn	13
Winter	6
Spring	8

Only 2 of the 29 patients were born during the summer months of June, July, and August, whereas at least 3 times as many were born

in each of the other seasons. This distribution of birth dates is unlikely to have occurred by chance (χ^2=8.66, 3*df*, $P<0.05$). The seasonal incidence of 38,893 consecutive live births in Milwaukee during the period of study is such that a slightly greater number might actually be expected in the summer months. For statistical tabulation, however, the expected seasonal incidence was taken as equal—a conservative factor.

Of the 29 patients 7 were dead on arrival at this hospital. The remaining 22 exhibited a picture of dyspnea, cyanosis, tachycardia, hepatomegaly, and cardiomegaly, usually without heart murmurs, with the following frequencies:

Clinical finding	*Number of cases*
Dyspnea	21
Tachycardia	18
Hepatomegaly	16
No murmur	16
Cardiomegaly	12
Cyanosis	11

It is also of interest that 17 of the 29 patients had gastrointestinal difficulties, most often vomiting or diarrhea or both.

The most fruitful investigative procedure was the chest roentgenogram. Unequivocal cardiomegaly was found in all 13 patients on whom chest films were taken. Electrocardiography was performed on 7 patients, in 5 of whom only the standard limb leads were recorded. Although some abnormality was noted in each case, the picture was quite variable. Indications of ventricular hypertrophy or strain, with prolonged QRS patterns and evidence of myocardial change, were frequent findings.

DISCUSSION

Theories concerning the etiology and pathogenesis of primary EFE are legion,[5,25,26] and there is not even general agreement whether the endocardial scar is a cause or an effect of the enlarged, diseased heart. It has been suggested not only that hypoxia[8,15] but also that hyperoxia[21] is in some way responsible. Much consideration has been given to the concept that the disease is itself a developmental or genetic defect.[7,17] The possibility has also been entertained that the lesion represents a collagen disease.[27] The theory that the etiology is fetal endocarditis has fallen into disfavor.

It is fairly well accepted that in at least some cases, EFE may be secondary to certain congenital malformations of the heart.[1,14] EFE

has been produced in rabbits by epinephrine injection and may be seen in cases of diphtheria.[15] To the extent of these observations, at least, we know EFE to be nonspecific.

Compared with their incidence in most developmental cardiac malformations, extracardiac defects are rarely associated with primary EFE. Although this infrequent association is also the experience in our series and tends to militate against the congenital—in the usual sense—origin of primary EFE, it is far from conclusive evidence.

The possibility that primary EFE might represent some interaction of viral and hypoxic insult to the heart has been entertained by others.[28] Our observation of a seasonal incidence may add some weight to this conjecture.

The singular pathophysiology of early life is being increasingly recognized. The unique enzymatic behavior of the young organism has led Kretchmer [29] to seek a biochemical definition of immaturity. Like these enzymatic phenomena, and like retrolental fibroplasia, EFE is a disease of early life with no counterpart in the mature individual. It may be postulated that EFE is an immature form of endomyocarditis produced by a seasonally variable insult, perhaps a virus, acting upon a predisposed organism, much as the scarred eye of retrolental fibroplasia results from the action of high oxygen concentration upon a predisposed organism. The scarred heart, like the scarred eye, shows little "inflammatory residue." In EFE the insult might be applied during intrauterine life or later. The paucity of extracardiac abnormalities suggests that the damage occurs later than that caused by maternal rubella, with its multiple organ involvement.

SUMMARY

The recent status of our knowledge of primary endocardial fibroelastosis is briefly outlined. A series of 29 previously unpublished cases, the largest single series published to date, is summarized. Primary endocardial fibroelastosis was found in nearly 3 percent of all autopsies at Milwaukee Children's Hospital.

The clinical and pathologic findings in this series were much the same as have previously been reported. It was noted, however, that only a small percentage of patients dying of primary endocardial fibroelastosis were born during the summer months—an apparent seasonal incidence that is described for the first time.

A discussion of etiology is undertaken. It is postulated that some form of seasonally dependent fetal or neonatal endomyocarditis may be concerned in the pathogenesis of primary endocardial fibroelastosis.

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ACCEPTED FOR PUBLICATION

What to select out of the mass of articles pouring into an editorial office is the biggest problem we have to deal with. In the long run it is upon the selection of articles to be published that a medical journal is judged—that and selection of its leading articles. We take—or try to take—endless pains in selecting the articles that are to be published. In spite of these efforts, we make many mistakes, which we hope readers will not notice, but usually they do. The great thing is to get oneself a high standard and to try not to fall below it. It is, of course, not possible for one man to be able to assess all, or even more than a part, of the papers that are submitted for publication. I should think that at least 70 per cent of those submitted to the *British Medical Journal* are read by two and probably three persons before a decision is reached on whether or not to publish. But the final decision is made by the editor, whose job it is to weigh the evidence of the experts and to take into consideration such practical problems as space and the varied interests of readers.—HUGH CLEGG: Some Principles and Problems of Medical Editing. *International Record of Medicine,* July 1960.

A Nursery Epidemic of Staphylococcic Infection

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NURSERY TRANSMISSION of staphylococcic disease constitutes a major public health problem throughout the world. Not only is this disease a threat to the newborn infant, but it also provides a route for transmission of antibiotic-resistant organisms to the community. Maternal breast abscesses and furunculosis in parents and siblings of recently delivered infants are well-recognized problems, and more serious staphylococcic infections may frequently be encountered.

It is thought that the recent increase in hospital-acquired infections is related to the extensive use of antibiotics and the creation of a hospital environment favorable to antibiotic-resistant organisms. The numerous factors involved in this complex problem, however, are yet to be clearly defined.

In this report we shall describe a recent outbreak of staphylococcic disease in infants delivered at Walter Reed General Hospital and the manner in which it was controlled.

MATERIAL AND METHODS

Clinical Observations

An increased number of skin lesions, manifested by pustules, blebs, or abscesses during the neonatal period (fig. 1) was noted by a physician in the pediatric outpatient department in November 1958. Following this initial observation all physicians were made aware of the potential

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problem. As a result, specimens from all suspicious skin lesions found in newborn infants from our nursery were cultured, and if staphylococcus was isolated, phage typing was done. Since more than 90 percent of infants delivered at this hospital attend our outpatient clinic, it was possible to follow nearly all infants who were born in the period 9 November 1958 to 30 April 1959. All infants included in this study were followed at least until their 6-week check-up, but the majority were observed even longer. During this period 41 staphylococcic infections were seen in 39 infants; the types of infection encountered were as follows:

Infection	*Number of cases*	
Dermatitis	29	(2 with associated abscesses)
Breast abscess	4	(1 with dermatitis)
Skin abscess	6	(1 with dermatitis)
Paronychia	1	
Pneumonia	1	
	41	(39 patients)

Phage typing in these 39 cases gave the following results:

Phage type	*Number of cases*
52/44A/42B/81	28
79	1
3A	2
52/44A/42B	1
42B/81	2
Nontypable	3
Lost	2
	39

An extremely high incidence of staphylococcic infection occurred in infants born during November, December, January, and the early part of February of 1958–59 (table 1). It should be pointed out, however, that many of these infections consisted of a mild dermatitis detected only at the time of the infant's routine 6-week check-up. The reported incidence of disease is therefore undoubtedly increased by the examining physicians' awareness of the problem.

During the early part of February the department of bacteriology, Walter Reed Institute of Research, was asked to help survey the situation. With the approval of the hospital Cross Infection Committee a study of the problem was undertaken.

At the time the investigation was started, the nursery at Walter Reed General Hospital was a single room measuring 26 feet by 38 feet. It had an average daily census of 13.2 infants with peaks of 22.

Figure 1. Typical dermatitis and abscess formation.

Table 1. ***Staphylococcic infections by month of occurrence in infants born between 9 November 1958 and 30 April 1959***

	November 1958	*December 1958*	*January 1959*	*February 1959****	*March 1959*	*April 1959*
Number of infants born	52	96	87	86	101	124
Number of infants discharged	52	92 (5 deaths)**	85 (2 deaths)**	86 (3 deaths)**	103 (2 deaths)**	128 (3 deaths)**
Total hospital days	288	416	477	477	345	495
Average daily census	11.8	13.42	15.38	15.9	11.1	16.5
Average days in hospital	4.39	3.93	5.61	5.1	3.41	3.91
Total cases of staphylococcic infection*	8	8	17	6	0	0
Incidence	15.4%	8.3%	19.5%	7.0%	0%	0%

*Based on date of discharge from hospital.

**No deaths were attributed to staphylococcic infections.

***Preventive measures instituted in mid-February. No cases were detected 1 week after these measures were started.

The nurses wore scrub dresses and no masks. Penicillin and streptomycin were administered routinely to small premature infants, infants having signs of respiratory distress, and those delivered more than 24 hours after rupture of membranes. The nursery floors were mopped with water and a liquid soap.

Laboratory Studies

In the initial survey, nasal and rectal cultures were obtained from all infants and mothers and personnel in the pediatric and obstetric services; 75 cultures of fomites and air were taken in the nursery and obstetric ward. Swabs were streaked directly on mannitol-salt agar culture plates. Mannitol-positive organisms were tested for coagulase activity, and coagulase-positive organisms were phage typed by a modification of the Blair and Carr [1] method. Instead of the usual flat agar plate, plates were devised with depressions into which phage was dropped.

These cultures revealed that of the 17 infants in the nursery 7 were "colonized with" (that is, were asymptomatic carriers of [2]) the 52/44A/42B/81 strain of staphylococcus. Of the 5 registered nurses working in the nursery, 4 were found to be nasal carriers of this strain. The strain was also obtained from 2 of the 29 personnel on the obstetric service. This organism was not recovered either from the doctors working in the nursery and delivery suite or from the mothers. Of the fomite cultures, 2 were found to be positive. These fomites were (1) an exposed plate that was kept in the nursery for 6 hours and (2) an exposed plate that was kept under the exhaust fan in the hall outside the nursery. Both plates grew phage type 52/44A/42B/81.

Methods of Control

With the foregoing information all nasal carriers of the offending organism were treated with intranasal neomycin-bacitracin ointment 4 times daily for 3 weeks. Others have suggested that personnel carrying the epidemic strain should be excluded from the nursery; [2] however, in our situation this was not practical because known staphylococcus-free trained personnel were not available to substitute. At the end of 3 weeks all former carriers were free of the offending strain of staphylococcus. During the next 12 months, as determined by culture every 2 weeks, not one nurse became recolonized with the epidemic strain.

In order to discourage the "routine" use of penicillin and strepto-

Figure 2. Nurse wearing plastic face shield, plastic extension, and plastic gown.

mycin, these antibiotics were no longer stored in the nursery. The subsequent use of antibiotics was individualized rather than made routine, and in each case the antibiotic that was chosen was thought or determined to be effective against the etiologic organism.

Although washing the hands before and after touching infants was considered to be a rountine procedure, the importance was emphasized and re-emphasized to all personnel. Instructions were given to wash with pHisoHex for 1 minute before and after handling each infant, with a 3-minute scrub upon entering the nursery. Each nurse was provided with a plastic laboratory face shield to wear when she handled an infant. The shield was adapted by attaching a sheet

of flexible plastic to its lower border, and the sheet was tucked into the nurse's gown to prevent upper respiratory organisms from falling upon the infant (fig. 2). Although not tight fitting, the face shield proved cumbersome; as soon as the carrier state had been eliminated, its use was discontinued.

On admission to the nursery each infant was assigned a plastic apron with long sleeves, which was worn by the nurse when handling that particular infant. Thus, the infant came into contact only with "his" apron. When an infant was discharged, "his" apron was soaked in a 1:1,000 solution of Zephiran (benzalkonium) chloride before it was assigned to another infant. The nursery floors were cleaned with a solution of Wescodyne and water instead of soap and water.

As soon as the foregoing alterations were initiated, a plan of bacteriologic surveillance of both infants and personnel was also begun. Cultures were taken from the anterior nares of each infant at the time of discharge and from each of the nursery personnel every 2 weeks. It immediately became apparent that this would overtax our laboratory facilities unless identification of the offending organism was simplified. Therefore, mannitol-salt agar was modified by the addition of 1 unit of penicillin per ml of medium. All survey cultures were grown on this medium, and only mannitol-positive, penicillin-resistant organisms were picked for further identification. The latter procedure appeared a logical one, since the organism of concern was penicillin resistant and mannitol positive. Thus, the laboratory results were made available much more rapidly and with less labor.

In addition to the bacteriologic surveillance, the infants were closely followed after discharge from the hospital. The mothers were contacted by telephone 4 and 10 days after discharge and questioned regarding their infant's well-being, and any questionable complaint was cause for a clinic visit. In any event, nearly all infants were seen in the pediatric clinic 6 weeks following delivery and were carefully examined for staphylococcic disease, any suspicious skin lesion being cultured.

In the 3 months of this bacteriologic surveillance, not 1 infant was found to be colonized with the penicillin-resistant 52/44A/42B/81 strain. As a result, in a follow-up of these infants the incidence of staphylococcic disease was nil.

DISCUSSION

The elimination of this nursery-acquired staphylococcic colonization, and subsequent infection, was the result of a combination of factors.

First, and probably most important, was the recognition that a problem existed. Every physician who examines infants must be aware of the potential hazard of keeping them in nurseries and must investigate any suspicious skin lesions, conjunctivitis, and abscesses. If an epidemic is to be recognized, all cases of neonatal staphylococcic infection must be tabulated at a central point and the incidence calculated monthly. It is generally accepted that any incidence above 1 percent per month indicates that a problem is present and that nursery technics should be scrutinized.[3]

Recognition and treatment of nasal carriers was the second important factor in this study. Since removing carriers from the nursery was impractical, they were treated intranasally with neomycin-bacitracin ointment. Their failure to become recolonized was probably due to the fact that while they were on treatment all infants with this strain were discharged. This, combined with the liberal use of disinfectant, effectively removed the 52/44A/42B/81 strain from the nursery.

It should constantly be stressed that the personnel of a nursery must fully understand the potential danger. Even though certain procedures are part of a "routine," they never seem really important to a person unless he is fully aware of the problem. Everyone who works in our nursery is constantly reminded of the potential danger. Working technics are continually scrutinized for possible improvements, and easier technics that would not in any way lower our standards are constantly sought. The use of face shields and plastic aprons in our nursery placed effective barriers between personnel and infants, as well as between one infant and another. Their effectiveness is attested to by the fact that 1 premature infant who was colonized with the offending organism at the beginning of the study and whose nasal culture was still positive at the time of discharge remained in the nursery for 2 weeks without transfer of the organism to another infant.

The presence of antibiotics in the hospital environment is thought to be significant in the colonization of the anterior nares with potentially pathogenic staphylococci.[4] In a nursery where antibiotics are frequently administered to infants, and then recontributed to the environment through their urine, the concentration of environmental antibiotics can easily reach significant proportions. Thus, the elimination of penicillin and streptomycin from the nursery removed what may be an important selective factor in the nasal colonization of both infants and personnel with pathogenic staphylococci.

SUMMARY

In January 1959 the incidence of staphylococcic infection in infants born at Walter Reed General Hospital reached 19 percent. This epidemic was detected primarily because of the examining physicians' awareness of the possibility of staphylococcic infections. Mannitol-salt agar to which penicillin was added was found to be a useful screening medium. Nasal carriers need not be excluded from the nursery if a strict aseptic technic is used, with emphasis on the washing of hands, and if these carriers are treated with intranasal antibiotic ointment. The use of antibiotics in our nursery only when specific therapeutic indications exist is thought to be a factor in lowering the rate of infant colonization with potentially epidemic staphylococci. Although impossible to measure quantitatively, a continuous program of educating nursery personnel on the potential hazards of nursery-acquired infection may be the most important factor in preventing these infections. We have found constant bacteriologic surveillance a useful tool for educational purposes.

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THREATS TO MEDICINE

> Every insubstantial statement about a new drug or therapy that is published provides a threat to good medical practice and is a serious menace to progress. It therefore concerns all interested in medicine; it concerns the patient, it concerns the practicing physician, it concerns those who evaluate new drugs and therapies.—Walter Modell: The Ethical Obligations to the Nonsubject. (Editorial) *Clinical Pharmacology and Therapeutics*, March-April 1960.

Medical Service Planning Factors

COLONEL JOHN E. BOYSEN, USAF, MC

ARE YOU PLANNING TO CONSTRUCT a new hospital? How many beds should you provide? How many will be needed for surgical, medical, or obstetric services? How many deliveries can you expect per month? How many surgical procedures? What will be needed in terms of staff physicians? These are a few of the many questions facing those whose jobs require a reasonable answer. The purpose of this article is to present a few of the rules of thumb that may prove useful.

APPROACH TO THE PROBLEM

Obviously a multitude of variable factors determine the extent of medical care offered in any one medical facility as compared with another. As one approaches this problem, however, it seems logical to begin with the assumption that the starting point should be a facility providing virtually 100 percent of the care required by a given population group. Such a facility would represent the ultimate and actual requirement, unlimited by the qualifications of the professional staff or the facility's physical capability and equipment. It also appears obvious that over a long period of time a given population group, no matter where it is located, would tend to generate approximately the same number of newborn infants, the same number of appendectomies, the same number of major fractures, and in other words, the same or similar requirements for total medical care. The only exceptions to this would be expected where unusual conditions such as malaria, parasitic infections, and tropical diseases may be prevalent.

The U.S. Air Force Hospital, Wiesbaden, Germany, appeared to be an ideal facility to provide experience factors of this type. It serves a population of over 6,000 military personnel, over 6,000 military

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From Office of the Surgeon, Headquarters U.S. Air Force in Europe. Colonel Boysen is now assigned to the Professional Services Division, Office of the Surgeon, Air Materiel Command, Wright-Patterson Air Force Base, Ohio.

dependents, and approximately 1,500 Department of the Air Force civilian employees and their dependents. This constitutes a population large enough to be used for predictive purposes. This group of approximately 14,000 people provided approximately 8,000 hospital admissions during 2 calendar years—a period long enough to level off temporary increases or decreases in hospitalization due to staff changes or seasonal incidence of acute infectious diseases. The group studied was essentially a "captive" population in the sense that almost all its medical requirements were met in this hospital. Little was taken care of in the local civilian community; there was no Medicare; and only an insignificant number of patients were transferred to the United States for further care.

No attempt has been made to make this study either age or sex specific or to take into consideration a number of other variables that it was believed would tend to cancel each other. One notable exception would be a locale with a large number of retired personnel receiving care; here, requirements would obviously be altered.

The data included here can be applied to population groups served by other facilities only by taking account of certain limitations. With new therapeutic technics and new concepts of medical care, the utilization of hospital beds changes. Length of hospitalization, for example, has progressively decreased over the past years, and patients who were formerly hospitalized routinely are now treated as outpatients. Such trends can certainly be expected to continue. The U.S. Air Force is fully aware of these changes and is accordingly proceeding to develop new factors.

METHOD OF STUDY

The period of study covered the calendar years 1957 and 1958. The population group included only those personnel who resided in the Wiesbaden area and received their total hospitalization in the U.S. Air Force Hospital. The admission rates, average hospital stay per case, and bed requirements were computed separately for (1) military personnel—predominantly men; (2) military dependents—predominantly wives and children; and (3) "others"—male and female Department of the Air Force civilian employees and their dependents.

None of the rates include "quarters" cases. In some cases hospitalized patients were placed on "quarters" status later, but only the period of hospitalization was made a part of this study. All factors, unless otherwise identified, are corrected to a population group of 1,000 personnel. All figures are taken from the average (arithmetic mean) for the 2 years under consideration.

FINDINGS

Admission Rates

Of a total 233.3 admissions per annum of military personnel per 1,000 assigned, 118.8 per 1,000 were admitted to the medical services, 112.6

Table 1. ***Rate of hospital admissions,* 1957–1958***

Specialty	*Number of admissions per annum per 1,000*		
	Military	*Military dependents*	*Others*
MEDICAL SERVICES			
Medicine, general	28. 5	22. 1	30. 1
Pulmonary-respiratory	63. 3	11. 6	10. 2
Gastrointestinal	9. 4	5. 1	5. 4
Cardiovascular	2. 8	1. 9	7. 8
Allergy	1. 0	2. 4	3. 4
Dermatology	4. 0	1. 6	1. 1
Psychiatry	9. 8	4. 9	8. 4
Pediatrics	–	20. 7	7. 1
Total	118. 8	70. 3	73. 5
SURGICAL SERVICES			
Surgery, general	37. 0	23. 0	31. 4
Orthopedics	24. 1	7. 3	11. 1
Thoracic	1. 6	1. 2	1. 7
Neurosurgery	7. 9	3. 8	6. 1
Ophthalmology	8. 1	8. 0	7. 8
Otolaryngology	12. 6	13. 4	7. 8
Urology	18. 8	13. 8	14. 2
Cancer	0. 7	0. 9	4. 4
Dental	1. 8	0. 7	0. 4
Total	112. 6	72. 1	84. 9
OBSTETRICS-GYNECOLOGY SERVICES			
Obstetrics	0. 6	112. 1	46. 3
Gynecology	1. 3	22. 0	15. 9
Newborn infants	–	88. 5	37. 8
Total	1. 9	222. 6	100. 0
Grand total	233. 3	365. 0	258. 4

*"Quarters" cases not included.

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Table 2. ***Average length of hospitalization,* 1957–1958***

Specialty	*Average length of hospitalization (days per case)*		
	Military	*Military dependents*	*Others*
MEDICAL SERVICES			
Medicine, general	9. 4	4. 5	6. 9
Pulmonary-respiratory	15. 2	7. 7	8. 5
Gastrointestinal	8. 2	7. 7	8. 4
Cardiovascular	13. 9	14. 6	8. 9
Allergy	7. 9	5. 5	6. 1
Dermatology	15. 9	8. 0	3. 2
Psychiatry	8. 7	6. 8	6. 9
Pediatrics	–	7. 1	5. 8
Total	12. 7	6. 6	7. 3
SURGICAL SERVICES			
Surgery, general	13. 4	5. 7	7. 4
Orthopedics	20. 7	7. 5	13. 4
Thoracic	29. 0	13. 3	14. 0
Neurosurgery	14. 6	10. 9	8. 4
Ophthalmology	9. 5	2. 9	5. 0
Otolaryngology	6. 8	4. 2	3. 8
Urology	6. 0	4. 7	6. 1
Cancer	32. 0	13. 6	12. 8
Dental	24. 9	3. 0	7. 0
Total	13. 3	6. 0	7. 9
OBSTETRICS-GYNECOLOGY SERVICES			
Obstetrics	7. 7	4. 8	5. 1
Gynecology	7. 1	5. 6	4. 7
Newborn infants	–	5. 1	5. 1
Total	7. 3	5. 0	5. 0
Grand total	12. 9	5. 5	6. 5

*"Quarters" cases not included.

per 1,000 to the surgical services, and 1.9 per 1,000 to the obstetrics-gynecology service (table 1). This compares with 365 admissions per 1,000 military dependents and 258.4 per 1,000 "others." There were 88.5 newborn infants per 1,000 military dependents per annum, or 7.4 per month. The high admission rate for "pulmonary-respiratory" diseases includes the influenza epidemic of 1957, when there

were 100.5 admissions per 1,000 military personnel per annum compared with 26.2 admissions per 1,000 per annum in 1958.

Bed Requirements

The total bed requirement per day for 1,000 military personnel was 8.2, for military dependents 5.4, and for "others" 4.6 (table 3).

Table 3. ***Hospital bed requirements, 1957–1958***

Specialty	*Beds per day per 1,000*		
	Military	*Military dependents*	*Others*
MEDICAL SERVICES			
Medicine, general	0. 7	0. 3	0. 6
Pulmonary-respiratory	2. 6	0. 2	0. 2
Gastrointestinal	0. 2	0. 1	0. 1
Cardiovascular	0. 1	0. 1	0. 2
Allergy	<0. 1	<0. 1	0. 1
Dermatology	0. 2	<0. 1	<0. 1
Psychiatry	0. 2	0. 1	0. 2
Pediatrics	–	0. 4	0. 1
Total	4. 1	1. 3	1. 5
SURGICAL SERVICES			
Surgery, general	1. 4	0. 4	0. 6
Orthopedics	1. 4	0. 2	0. 4
Thoracic	0. 1	0. 1	0. 1
Neurosurgery	0. 3	0. 1	0. 1
Ophthalmology	0. 2	0. 1	0. 1
Otolaryngology	0. 2	0. 1	0. 1
Urology	0. 3	0. 2	0. 2
Cancer	0. 1	<0. 1	0. 2
Dental	0. 1	<0. 1	<0. 1
Total	4. 1	1. 2	1. 8
OBSTETRICS-GYNECOLOGY SERVICES			
Obstetrics	<0. 1	1. 4	0. 6
Gynecology	<0. 1	0. 3	0. 2
Newborn infants	–	1. 2	0. 5
Total	<0. 1	2. 9	1. 3
Grand total	8. 2	5. 4	4. 6

Length of Hospitalization

The average hospital stay per case was 12.9 days for military personnel, 5.5 days for dependents, and 6.5 days for "others" (table 2). This difference is partly due to the larger number of military personnel admitted for major trauma (general surgery and orthopedics) and to the significantly larger number of military personnel hospitalized for a longer period of time because they have no "home" in which to convalesce.

Surgical Procedures

The incidence of surgical procedures was studied for the year 1958 only (table 4). These data were taken from Form 481, Clinical Record Cover Sheet, and include only the primary surgical procedure performed. Thus, a prophylactic appendectomy incidental to a cholecystectomy would not be included. Approximately 68.5 surgical procedures were performed per 1,000 military personnel, compared with 203.2 per 1,000 military dependents and 123.2 per 1,000 "others."

Table 4. ***Rate of surgical procedures, 1958***

		Number of surgical procedures per 1,000					
		Per annum			*Per month*		
Class	*Procedure*	*Military*	*Military dependents*	*Other*	*Military*	*Military dependents*	*Other*
I	Neurosurgery	1.6	2.4	3.4	0.13	0.20	0.28
II	Eyes, ears, nose, throat	11.9	18.0	8.1	0.99	1.50	0.68
III	Oral surgery	1.4	1.3	–	0.12	0.11	–
IV	Thoracic surgery	1.9	1.0	–	0.16	0.08	–
V	Gastrointestinal and abdomen	17.2	11.3	19.5	1.43	0.94	1.63
VI	Genitourinary	10.9	38.6	17.5	0.91	3.22	1.46
VII	Gynecology and obstetrics	1.1	112.0	52.5	0.09	9.33	4.38
VIII	Orthopedic	5.9	5.4	5.4	0.49	0.45	0.45
IX	Other	16.6	13.2	16.8	1.38	1.10	1.40
	Total	68.5	203.2	123.2	5.70	16.93	10.28

Table 5. ***Rate and length of hospitalization for selected operations, 1957–1958***

	Rate (number/annum/1,000)			*Length of hospitalization (days/case)*		
Surgical procedure	*Military*	*Military dependents*	*Others*	*Military*	*Military dependents*	*Others*
Appendectomy	2.3	1.8	1.4	16.7	7.0	7.0
Herniorrhapy	4.7	3.9	5.4	17.3	5.3	9.3
Hemorrhoidectomy	4.8	1.9	4.4	16.2	9.5	7.1

The rate and length of hospitalization for the more common surgical procedures were examined for both 1957 and 1958 (table 5). The significantly long hospitalization for military personnel again reflects the necessity for retaining convalescent men who would otherwise be forced to return to barracks.

"Rules of Thumb"

A few "rules of thumb" have been computed from the basic statistics (table 6). Thus, for each group of 1,000 military personnel, we should expect to need 8.2 beds per day; for every 1,000 dependents we should expect 7.4 deliveries per month; and from the same group we may anticipate a total of 16.9 surgical procedures.

Table 6. *"Rules of thumb"*

	Military	*Military dependents*	*Others*
1. Bed requirement (total per day)	8.2	5.4	4.6
2. Admissions to medical service*	9.9	5.8	6.1
3. Admissions to surgical service*	9.4	6.0	7.1
4. Admissions to obstetrics-gynecology service*	0.1	18.6	8.3
5. Surgical procedures*	5.7	16.9	10.3
6. Appendectomies*	0.2	0.15	0.12
7. Herniorrhaphies*	0.4	0.33	0.45
8. Hemorrhoidectomies*	0.4	0.16	0.37
9. Deliveries*	–	7.4	3.2
10. Number of personnel required to generate:			
20 deliveries per month	–	2703	6250
30 deliveries per month	–	4054	9375

*Units per 1,000 per month.

SOME PRACTICAL APPLICATIONS

The use of the factors developed and presented here is limited only by the ingenuity of the "planner." As a sample of the possible applications, an approach to 2 separate problems is presented, together with a simple form on which to develop the answers.

Work sheet "A" (table 7) is an attempt to solve the problem of how many beds to provide in an area hospital that serves a group of satellite hospitals or dispensaries. It might also be used to predict the use of Medicare in a hospital in the United States. The proce-

Table 7. *Work sheet "A," bed requirements*

A *Name of facility*	B *Personnel category*	C *Strength +1,000*	D *Bed requirement factor*	E *Computed total requirement*	F *Capability factor*	G *Adjusted requirement*	H *Excess (to area hospital)*
I	Military		8.2				
	Military dependents		5.4				
	Other		4.6				
II	Military		8.2				
	Military dependents		5.4				
	Other		4.6				
III	Military		8.2				
	Military dependents		5.4				
	Other		4.6				
IV	Military		8.2				
	Military dependents		5.4				
	Other		4.6				
V	Military		8.2				
	Military dependents		5.4				
	Other		4.6				
Total excess bed requirement for area hospital	Military	////////////////////////////////					
	Military dependents	////////////////////////////////					
	Other	////////////////////////////////					

A *Name* of medical facility.

B *Personnel category*—i.e., Military/Military dependents/Others.

C *Strength*—Number of individuals in thousands in each category who are potentially dependent upon this facility for medical care. For example, if there are 6,600 military personnel, enter "6.6."

D *Bed requirement factor*—These factors are derived from table 3.

E *Computed total requirement*—This is obtained by multiplying the entries in columns C and D.

F *Capability factor*—It is expressed as a percentage, i.e., 85 percent. This may be obtained by deducting from the total requirement those bed requirements (table 4) for specialty services not available at a given facility plus a fraction of some of the major services such as general surgery. It may also be based upon past experience with a given facility, comparing its average bed occupancy as the numerator of a fraction in which the denominator is the calculated total requirement (column E).

G *Adjusted requirement*—Multiply columns E and F. This product is the "adjusted requirement."

H *Excess*—Column E minus column G represents the number of beds required in excess of those that can be provided in this small medical facility. Added together, these beds would be the requirement for the area hospital. If an average bed occupancy of 80 percent is desired, the total "excess" should be multiplied by a factor of "1.25" to arrive at the final number of beds to be authorized.

dure described in steps "A" through "H" would give an estimate of actual requirements based upon lack of capability of a given facility, rather than upon personal whims and preferences of individual

patients who may have the prerogative of choosing either military or civilian medical care.

Table 8. ***Work sheet "B," projected workload (per month)***

		Military		*Military dependents*		*Other*	
		Factor	*Calculated*	*Factor*	*Calculated*	*Factor*	*Calculated*
Facility							
	Strength (in thousands)		////////		////////		////////
	Admissions, medical service	9.9		5.8		6.1	
	Admissions, surgical service	9.4		6.0		7.1	
	Admissions, obstetrics-gynecology service	0.1	////////	18.6		8.3	
	Deliveries	////////	////////	7.4		3.2	
	Surgical procedures (total)	5.7		16.9		10.3	
	Appendectomies	0.2		0.15		0.12	
	Herniorrhaphies	0.4		0.33		0.45	
	Hemorrhoidectomies	0.4		0.16		0.37	

Work sheet "B" (table 8) can be used to estimate workload figures, from which staffing requirements can be derived. Again, the basis for this is the size of the population. From this such factors as the total number of admissions by diagnostic category or service, the number of deliveries, and the number of surgical procedures can be determined. When these various estimates have been calculated, it will be up to the planner to decide whether the number of deliveries will be sufficient to warrant the assignment of 1 or more obstetricians; or whether the number of surgical procedures expected is sufficient to employ a surgeon "gainfully." This process can be expanded to any desired extent.

DISCUSSION

In a review of similar statistics published by the U.S. Air Force,[1] the hospitalization ratios for Air Force personnel, world wide, are reported as follows:

Year	*Patients occupying beds/1,000/day*
1951	13.1
1952	11.6
1953	10.4
1954	8.9
1955	8.4

This compares with the bed requirement of 8.2 patients per day per 1,000 military personnel shown in table 3. In the same report, admission rates also declined in much the same fashion:

Year	*Admissions/year/ 1,000 strength*
1951	386
1952	321
1953	313
1954	279
1955	269

This compares with the admission rate of 233.3, also a decline, shown in table 1.

It is extremely important that the reader understand the implications and applications of the foregoing data. He must understand, for example, that the number of admissions, the number of deliveries, the number of appendectomies included are taken solely from the population group residing in Wiesbaden and do *not* include other patients residing or originating outside this geographic area. For example, on a typical day, from 85 to 90 beds were occupied by "Wiesbaden people," and an additional 150-odd beds were occupied by personnel from other stations and bases throughout USAFE. This latter group are *not* included in this study, either in the numerator or in the denominator of any ratio. For this reason, the experience factors as given represent the medical *requirements* of this population group and should be representative of most other Air Force population groups.

The distinction between *requirements* for medical care and actual *workload* experienced must also be understood. For example, given the size of a population on any base, one might predict that 24 deliveries would occur per month. If the decision were made that no obstetric service would be provided, then it would be reasonable to expect that 24 obstetric Medicare certificates would be executed per month. Therefore, in this instance, the *requirement* is 24 per month, the workload expected would be zero, as far as "in-house deliveries" are concerned. Or take, as an additional example, a given base medical service where one might predict a *requirement* for 20 surgical procedures per month but where only one "D" level surgeon with minimal support has been assigned. He would, with good judgment, transfer 90 percent of these because they included orthopedic, ophthalmologic, and neurosurgical cases beyond his capability. Consequently, his *workload* would be approximately 2.0 procedures per month, the other 18 having been transferred to other specialty hospitals or perhaps handled under Medicare.

This study, then, is an attempt to provide a medical planner with *requirement* factors only, taken from an isolated situation in which all requirements for medical care were met. These factors could thus be used as a basis for the planner to predict workloads modified by known or estimated factors, such as limited facilities, limited staffing, or, in the case of specialty centers, the increased workload generated by other population groups from distant or satellite bases. Although limited staffing or facilities, the availablilty of Medicare or of Armed Services Medical Regulating Office–directed transfers—to mention only a few examples—do not affect the medical care requirements of a given population group, they obviously do affect the projected workload of a medical facility.

The number of cases transferred to the continental United States for Physical Examination Board action or long-term hospitalization (e.g., tuberculosis, malignancies) was too small to affect the statistics as given. The relatively long-term nature of cases in these latter categories is not considered to be of practical significance when these "rules of thumb" are applied to the average Air Force hospital because these hospitals also do not retain such cases. The impact on hospitals having Physical Examination Board capability is significant and must be estimated as an additional load factor.

SUMMARY

From a detailed study of the cases admitted to the U.S. Air Force Hospital, Wiesbaden, Germany, during the years 1957 and 1958, an attempt has been made to develop experience factors that would accurately depict medical care requirements for any given population group. Such factors, it was believed, would be useful for estimating specific requirements for new or expanding facilities, or even for judging the extent of care provided in existing facilities. These factors have been calculated and examples of their use are presented.

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REFERENCE

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Synovial Osteochondromatosis

With Report of Four Cases, One Showing Malignant Change

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SYNOVIAL OSTEOCHONDROMATOSIS provides one of several modes of production of loose bodies composed of organized tissue within joints, other conditions in this category being osteoarthritis, osteochondritis dissecans, and intra-articular fracture of bone or cartilage. Although these entities are entirely unrelated etiologically, an understanding of the pathology involved in each condition is helpful in emphasizing the unique characteristics of synovial osteochondromatosis.

Whereas the loose bodies arising as a result of osteochondritis dissecans, osteoarthritis, and fractures result from the detachment of osteocartilaginous material already present on the joint surface, the osteocartilaginous loose bodies arising in joints as the result of synovial osteochondromatosis are proliferated by the synovial membrane, and discharged into the joint. Here they either remain attached to the synovium by a small pedicle, or become free bodies within the joint.

Etymologically speaking, osteochondritis dissecans suggests a dissecting type of osteochondritis (now believed to be an osteochondrosis), which separates a portion of the articular cartilage and its subjacent bone from the joint surface. The exact nature of the process has remained obscure, but it is generally agreed that trauma probably plays a role in its initiation. No evidence of an infectious etiology has been found, and other factors, such as a compromised blood supply, either traumatic or embolic, have been implicated but not proved. The loose bodies arising secondary to an osteoarthritic process are

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formed by traumatic detachment of portions of the degenerated joint surface.[1, 2]

Loose bodies may also be formed in joints from unorganized, noncellular material, as, for example, the rice bodies or corpora oryzoidea formed in the exudate of tuberculous infections.

ETIOLOGY AND PATHOLOGY

The primary pathologic process in the case of synovial osteochondromatosis is generally held to be neoplastic in nature. It is conceivable that any condition resulting in synovial hyperplasia could initiate cartilaginous metaplasia within the synovia, with the subsequent proliferation of cartilaginous and osteocartilaginous tumors.[3] Examples of conditions that might initiate such a metaplastic process would include trauma with a subsequent chronic inflammatory reaction, and rheumatoid arthritis. Lexer,[4] in 1907, following the teachings of Virchow and Ribbert, held that synovial chondromas originate from scattered embryonic rests. According to this theory, these embryonic rests arise by a fault in mesenchymal differentiation during formation of the joint.

In 1927 Jones [5] reported a case of osteochondromatosis of the knee joint in which the process was relatively immature. At the time of the original operation the synovial membrane was found to be thickly studded with wartlike cartilaginous bodies, practically all of which were still attached to the synovium. Most of these cartilaginous bodies seemed to originate from the margin of the joint, where the synovial membrane joined the bone. The various stages of development of the cartilaginous bodies within the synovial membrane were examined microscopically, and were found to follow closely the embryonic method of development of cartilage described by Mall.[6] The findings in this case were offered as definite support for the theory that synovial chondromatosis was a neoplastic manifestation.

While the cartilaginous or osteocartilaginous loose bodies remain attached to the synovium, the nourishment for the noncartilaginous tissues is received through the synovial attachment. Any bony elements present may become well differentiated into cortical and cancellous bone, with associated small blood vessels, fibroblasts, fatty tissue, and blood elements. Once the loose bodies become detached from their blood supply these noncartilaginous elements are first to undergo degenerative changes, with accompanying dystrophic calcification. The cartilaginous elements are nourished by the synovial fluid and may actually increase in size, participating in what

Phemister [2] has likened to an in vitro tissue culture. This interesting phenomenon is the basis for a theory of traumatic origin of cartilaginous loose bodies proposed in 1923 by Henderson and Jones,[7] whose theory is that cartilage cells are separated from the joint surface by trauma and become in vivo tissue cultures, eventually developing into macroscopic loose bodies. This would account for chondromatous loose bodies in the presence of a normal synovial membrane. A traumatic synovial inflammatory reaction may aid this tissue culture by enriching the nourishment available from the synovial fluid.

INCIDENCE

A review of the literature between 1900 and 1951 by Bloom and Pattinson [8] revealed 187 cases of osteochondromatosis of all joints, to which these authors added 4 new cases. Approximately 9 percent of the patients demonstrated bilateral joint involvement. A summary of the joint distribution is as follows: knee cases, 110; elbow, 36; hip, 25; shoulder, 10; and miscellaneous joint involvement, including ankle, carpus, tarsus, and finger joints, 10 cases. This gives one some idea of the relative and absolute incidence of cases of synovial osteochondromatosis.

CASE REPORTS

Four cases of synovial osteochondromatosis seen at this hospital between the years 1952 and 1958 are presented here to illustrate various aspects of the history, physical findings, and roentgenographic and pathologic features of synovial osteochondromatosis. No didactic presentation of these points will be made since it is thought that they are adequately represented in the case studies and are available in previous excellent articles on the subject.

The cases are arranged in the order of diminishing degree of proliferative activity. The first represents the only known case of malignant change in synovial osteochondromatosis reported in the literature. Although Henderson and Jones [7] alluded to this possibility, the joint itself in their case did not show sarcomatous change. The second and third cases demonstrate an actively proliferating phase. In the fourth patient, all the cartilaginous loose bodies had reached the same stage of maturity, and no synovial reaction or active cartilaginous proliferation remained.

CASE 1. A 33-year-old white man first developed pain in his right hip on 20 December 1954, without definite history of antecedent trauma. Approximately 3 weeks after the onset of the pain, he was seen by his flight surgeon, and a diag-

nosis of arthritis was made. Treatment with diathermy was instituted. Physiotherapy was continued for several months, and because of shortening of the right lower extremity, a heel lift was applied to equalize the length. The pain steadily increased in severity, and the patient was transferred to this hospital for further evaluation on 23 March 1955.

Examination revealed that internal rotation of the right lower extremity caused extreme pain in the right hip. When standing, the patient was able to bear weight without pain by flexing the right hip and slightly bending the trunk forward. No weakness was noted in the right lower extremity, the pain did not radiate, and there was no measurable atrophy of the muscle groups of the lower extremities. Moderate limitation of motion was noted in the right hip joint. Roentgenograms of the right hip revealed no evidence of osteoporosis, irregularity, or narrowing of the joint spaces, or of sclerosis about either hip joint.

On 31 March the right hip joint was explored through a narrow femoral incision. When the joint was opened, approximately 250 ml of thick, bloody material escaped. On culture, this material proved to be negative for bacteria, including *Mycobacterium tuberculosis*. The joint was found to be filled with cartilaginous bodies varying in size from a fraction of a millimeter to 1 cm in diameter. As nearly as could be determined, these were all attached to the synovium, and literally hundreds of tiny bodies could be seen arising from the synovium itself. This cartilage was very moist, almost to the point of appearing succulent, soft and friable, and not at all like mature cartilage. The synovium was completely excised, but with some difficulty, since the cartilaginous bodies and synovium were

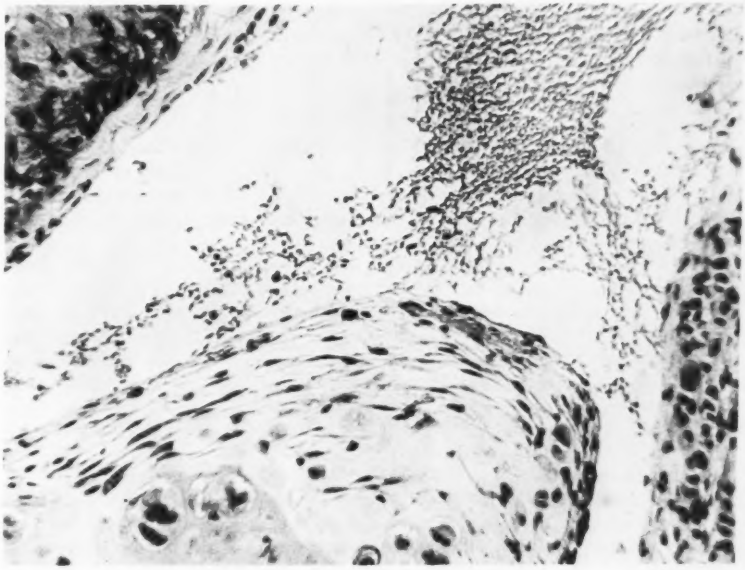

Figure 1 (case 1). Photomicrograph of a circular body arising beneath the synovial mucosa, showing proliferating cartilaginous tissue. (x 50)

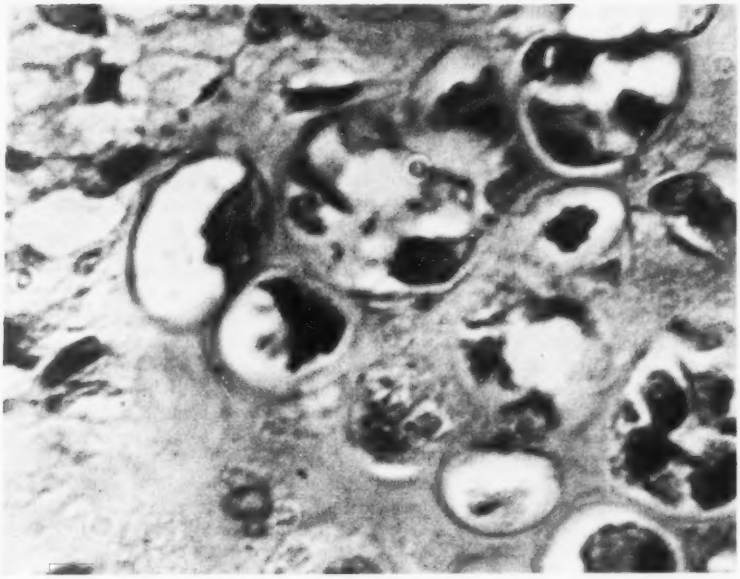

Figure 2 (case 1). Higher magnification showing giant, bizarre, distinctly hyperchromatic nuclei, with pleomorphism and an occasional prominent nucleolus. (x 430)

adherent to the neck of the femur, making it necessary to curet the chondromas vigorously from the rim of the femoral head. The marginal cartilage of the femoral head showed several areas of marked erosion. The remaining cartilage of the femoral head appeared normal. Synovectomy was accomplished without disarticulation of the hip.

Gross examination of the surgical specimen revealed numerous rounded cartilaginous bodies, measuring up to 1 cm in greatest diameter, arising from the synovium and projecting forward as polypoid masses, with no evidence of calcification or ossification. Microscopic examination revealed numerous circular bodies of proliferating cartilage arising beneath the synovial mucosa. The proliferating cartilage cells were large, somewhat pleomorphic, and had plump nuclei with prominent nucleoli and occasional mitotic figures. The lesions were cellular, and in some areas showed early ossification with minimal calcification (figs. 1 and 2).

Final pathologic diagnosis at this facility was osteochondromatosis of the hip joint, the bizarre microscopic picture being attributed to a recently associated chronic synovitis. The opinion that the lesion was nonmalignant was shared by several consulting pathologists, and the patient was discharged from the hospital 22 April, ambulating well on full weight-bearing and with a minimal limp. The surgical specimen was submitted to the Armed Forces Institute of Pathology, where the diagnosis of synovial chondromatosis of the hip was confirmed. How-

ever, attention was called to the fact that in some areas the proliferation had exceeded the limits permissible for a benign lesion and was undergoing transformation to a chondrosarcoma. Eventually this patient underwent a hind-quarter amputation at the hospital at Lackland Air Force Base, where the diagnosis of chondrosarcoma of the hip was confirmed.[9]

CASE 2. A 21-year-old white woman, gravida 2, para 2, was first admitted to another hospital on 8 February 1955, complaining of persistent pain deep in her right hip, which had its onset with her first pregnancy approximately 3 years before that admission and increased in severity with her second pregnancy. There was no remission of the pain after delivery of the second child. There was no specific history of trauma with or before the onset of the pain.

Findings on physical examination were not remarkable except for those of the back and right lower extremity. When lying in bed, standing, or walking, the patient kept her right hip flexed approximately 45°. The patient exhibited atrophy and weakness of the muscles of the right hip and thigh, and tenderness to palpation in the posterior aspect of the right hip joint. Motion of the hip was markedly restricted in all directions and any active motion appeared to be facilitated by tilting the pelvis. A 5° to 10° flexion contracture of the right hip was present. Roentgenograms of the right hip were reported as showing a well-preserved articular space, with no evidence of radiopaque bodies within the joint

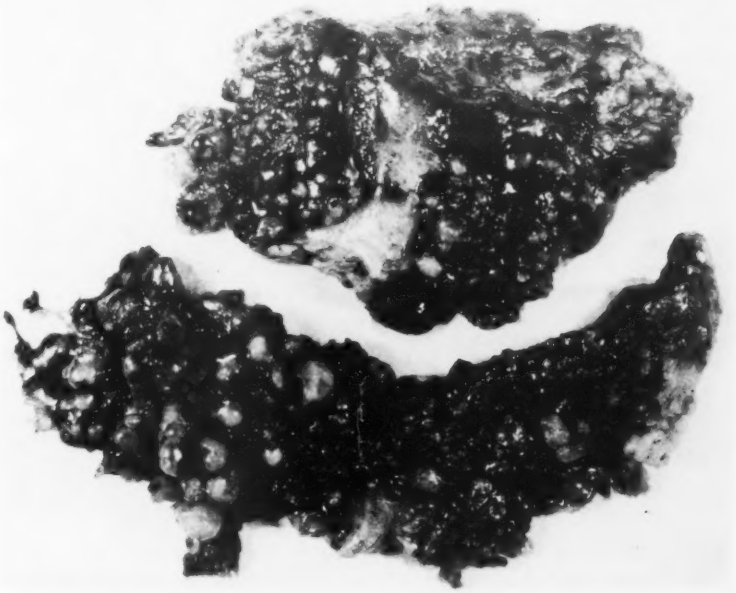

Figure 3 (case 2). Surgical specimen of synovium with projecting papilliform nodules of cartilage.

space and no arthritic changes. It was believed that this condition represented subpsoas or early pectineal bursitis, and conservative therapy was instituted before subjecting the patient to operative intervention.

On 4 March an arthrotomy of the right hip was performed through an anterior iliofemoral incision. When the joint capsule was entered, a small amount of blood-tinged fluid escaped. Further exploration revealed a layer of multiple cartilaginous bodies varying from pinpoint size to approximately 1 cm in diameter. These were agglutinated into a mass measuring approximately ¼ inch in thickness and filling the entire joint space. The exact nature of the condition was not immediately appreciated, and a frozen section revealed cartilage arising in the synovium itself. The entire anterolateral and most of the medial capsule and synovia were removed.

The synovia contained numerous papilliform nodules of cartilage. The cartilage cut with ease, and the cut section revealed numerous nodules of bluish white cartilage separated by hemorrhagic myxoid tissue. Microscopic examination showed these cartilage nodules to be made up of large, plump chondrocytes developing in the connective tissue of the synovium. No ossification or calcification was noted. It was not thought advisable to dislocate the hip completely and destroy any existing blood supply to the head through the ligamentum teres, which would be necessary in order to eradicate the synovium.

The patient was readmitted 24 August, complaining of pain in the right hip aggravated by standing or walking and also during menstrual periods. Roentgenograms of the right hip showed soft tissue calicification adjacent to the lateral margin of the acetabulum. The joint surfaces appeared to be relatively smooth except for a slight amount of sclerosis about the acetabular roof on the oblique view. After an extensive study of the case, it was decided that the calcification manifested on roentgenographic examination represented myositis ossificans, and was not due to recurrent osteochondromatosis. The patient was discharged to physiotherapy on an outpatient basis; no further follow-up is available.

CASE 3. This 23-year-old white male aviation cadet was first seen in the flight surgeon's office on 6 January 1954, at which time he complained of occasional pain in the region of the left deltoid muscle. The pain had been present for approximately 10 days, and was most prominent on raising his left arm. No history of antecedent trauma or of previous episodes similar to the present one was elicited. Physical examination revealed some limitation of adduction and abduction of the left arm. Crepitation was noted on moving the glenohumeral joint. Initial roentgenographic examination of the left shoulder revealed numerous calcific densities occupying the region of the shoulder joint.

The patient was transferred to this facility 28 January, where physical examination revealed, in addition to the previously described findings, some atrophy of the deltoid muscle on the left. Wide abduction and internal rotation of the left shoulder elicited a complaint of pain in the shoulder and an audible snap and palpable grating. Except for the slight limitation of motion imposed by the pain in the joint, there was full range of motion, with good function and strength of the left upper extremity.

On 26 March an arthrotomy was performed on the left shoulder joint through a shoulder strap–type incision. When the joint was opened, 51 separate osteochondritic nodules were found lying free within it and were removed. Inspection of the synovium revealed it to be studded with hundreds of minute chondromatous nodules, and a synovectomy was performed through a combination of anterior

and posterior incisions. Microscopic examination of sections of the loose bodies showed them to be made up of well-differentiated cartilage with areas of degeneration. The synovial membrane was lined by mesothelium of normal appearance in some areas; in other areas no mesothelial lining remained. The surrounding tissues were composed of fibrous tissue infiltrated by small numbers of lymphocytes. A few small areas of well-differentiated cartilage were located on the surface of the synovium. The Armed Forces Institute of Pathology confirmed the diagnosis of synovial osteochondromatosis. The patient was discharged from the hospital 29 July with moderate limitation of motion in the left shoulder joint. No follow-up is available.

CASE 4. A 53-year-old white man was admitted to this facility 12 March 1958, complaining of pain and limited motion in the right elbow joint of approximately 5 years' duration. The symptoms were minimal in severity, and there was very little restriction of motion. The chief areas of physical difficulty were encountered when the patient attempted to perform movements of the right elbow involving flexion and extension with simultaneous supination and pronation, such as in combing his hair. The history revealed that approximately 5 years before admission to the hospital he had slipped on the ice, sustaining minor trauma to the right elbow. No roentgenograms were taken at the time. Two years before admission to this facility he was treated at another Air Force hospital, where it was noted that he had difficulty in completely straightening the right elbow when this was placed on an arm board. Roentgenograms taken at that time revealed multiple osteocartilaginous loose bodies in the right elbow joint (fig. 4), but the patient was transferred to another facility before operative intervention could be undertaken. Roentgenograms of the right elbow on 12 March revealed multiple calcific densities lying within the joint space of the right elbow, both anteriorly and posteriorly (fig. 5).

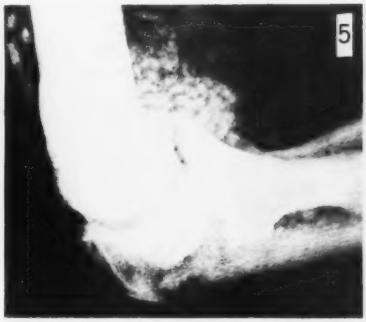

Figure 4 (case 4). Roentgenogram of right elbow in lateral projection, demonstrating presence of radiopaque loose bodies within joint capsule and between articulating surfaces of humerus and ulna.

Figure 5 (case 4). Roentgenogram of same elbow 2 years later, demonstrating progressing calcification of these loose bodies.

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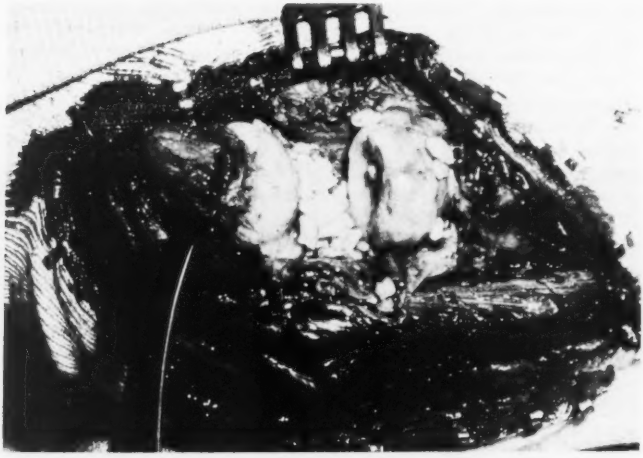

Figure 6 (case 4). Photograph of elbow, taken during operation. Joint capsule was packed with hundreds of these loose bodies.

On 13 March the right elbow joint was opened through a posterolateral incision. When the joint capsule was opened, hundreds of slightly lobulated, smooth, hard, light-gray nodules ranging from 0.2 to 0.6 cm in diameter were observed lying within the elbow joint (fig. 6). Several of the larger nodules were affixed to the synovial membrane by a short fibrous pedicle. There was also a proliferation of cartilage on the base of the radial head. The synovial membrane was examined throughout and found normal in appearance except for the occasional attachment of the osteocartilaginous loose bodies. All the loose bodies were relatively mature in development, and there were no newly developing ones on the synovial membrane itself. The loose bodies were all removed from the joint, their removal being facilitated by disarticulating the elbow joint after first mobilizing the ulnar nerve where it coursed across the elbow joint medially. The lesion attached to the head of the radius was excised and submitted as a separate specimen. Examination revealed these loose bodies to be made up of cartilage with large numbers of lacunae, each of which contained a single cartilage cell. Areas of calcification were noted but no true bone formation was seen in the sections examined. The roentgenographic report of 14 May described the development of one or two flecks of calcification adjacent to the lateral epicondyle of the humerus. When the patient was discharged from the hospital on 19 May, the right elbow joint showed 10° restriction in extension and a functioning elbow and forearm permitted full, strenuous use.

DISCUSSION

Taken as a group, these 4 cases of synovial osteochondromatosis are of particular interest because they indicate the protean nature of this neoplastic synovial process and present an interesting pathologic panorama.

The clinically and microscopically benign synovial membrane in the patient with osteochondromatosis of the elbow (case 4) exhibited the "burned-out" remnants of an obvious osteochondromatosis. The vagueness of the subjective complaints and virtual lack of positive physical findings compared with the packed density of the mature loose bodies was remarkable. The cartilaginous surface of the joint was in excellent condition, except for an occasional area of erosion, and could best be described as "dry" instead of the more normal "glistening smooth." Here was evidence of a state of arrested osteochondromatosis.

The second and third cases presented the usual florid state of synovial osteochondromatosis as seen during surgical intervention. In the patient whose shoulder was involved (case 3), a large number of the loose bodies had matured to a point at which they could be detected in the roentogenogram as calcific densities. Involvement of the hip in case 2, on the other hand, was diagnosed preoperatively as synovitis or bursitis, and there was no roentgenographic evidence whatsoever to suggest the gross synovial metaplasia found at operation. Both cases showed studding of the synovia with cartilaginous tissue and accumulation of loose bodies within the joint, seen progressing from the microscopic to the macroscopic stage throughout the joint, without apparent damage to the surface of the joint or the subjacent bone.

In case 1, by contrast, disease of the hip progressed violently upward through the stage of uncontrolled metaplasia, and there was evidence of transformation to chondrosarcoma within the substance of the synovial tissue.

If we speculate on the basis of these 4 cases, we see a course of activity, initiated by an unknown factor, beginning as a hyperplastic response of the synovial tissue, and resulting in metaplasia with the production of cartilaginous tissue. As the process progresses and the cartilaginous or osteocartilaginous loose bodies are released into the joint cavity, the synovium may return to a relatively normal state, leaving the joint with nothing more than the residuals of the proliferated bodies. If, on the other hand, the synovium continues to manifest these neoplastic changes without spontaneously becoming quiescent and without surgical extirpation, a sarcomatous change may intervene.

Whether the calcium deposits in the cartilaginous bodies represent a stage in the direction of maturity—or simply dystrophic calcification in the tissue of the loose body fed by the surrounding synovial fluid—is not known. The fact that calcium can be deposited almost simultaneously in the loose bodies suggests that calcium deposition

may be related to some extrinsic factor and may possibly represent a return of the synovium to a more quiescent state. The regularity, size, and configuration of the loose bodies, as well as the roentgenographic appearance of the elbow (case 4), suggests a sudden burst of proliferative activity with sudden cessation. Comparison of figures 4 and 5 shows that over a 2-year span the areas of calcification increased in size, with essentially no increase in number. An explosive phenomenon was previously reported by Hamada[10] in a case of osteochondromatosis of the hip in which hundreds of radiopaque loose bodies appeared in the joint over a 3-month period. This was followed by relative synovial quiescence after surgical removal of the loose bodies.

Various authors [5,11] have noted increased proliferation of the synovial chondromas at the synovial-cartilaginous junction. In all the cases presented in our report, a periarticular conglomeration of the loose bodies was seen. Whether this supports the opinion that there is a greater activity at the junction of joint synovium and cartilage is unknown. The mechanical functioning of the joint, in the presence of osteocartilaginous loose bodies shedding from the synovial tissue, suggests that the osteocartilaginous bodies may drift into the area of least activity and greatest accessibility, and become compact and then fixed.

As previously noted, there was a surprising lack of deformity of the cartilaginous elements of the joint surfaces in the 4 cases. This is in marked contrast to the usual findings in joints containing loose bodies of osteoarthritic or osteochondritic origin. In the 2 hip cases, one with malignant change, there was no roentgenographic evidence to suggest synovial osteochondromatosis. Bloom and Pattinson [8] called attention to areas of pressure resorption in the joint surface, as manifested on roentgenograms, as well as to erosions at the cervical-capital junction and a conical shape of the femoral neck. We did not note these findings in our 2 hip cases.

SUMMARY

Four cases of osteochondromatosis of synovial origin are presented: 2 of the hip, 1 of the shoulder, and 1 of the elbow. These cases, in which a wide range of subjective complaints and physical findings were observed, encompass a course of synovial cellular activity that ranged from the arrested to the malignant stage.

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THE MIASMA OF JARGON

I warn you of a new kind of jargon, whose cotton-wool coils are being wrapped closer around us every day—the jargon of officialdom and the jargon of committees. In this malignant hypertrophy of language, nobody says anything: they "state," or worse still they "intimate that." They never think: they "are of the opinion that." Nobody finishes anything: it is "duly completed." Nobody is paid: they "receive financial remuneration on a 9½/11ths basis." Nobody looks ahead: they "envisage a long-term policy." This language is a waste of duplicating-paper and a waste of time. Incompetence can hide behind its opacity and activity be smothered by its voluminous folds. I warn you of this deadly and contagious miasma. May I personally intimate to you that after due consideration I am of the opinion that it should be an integral part of your basic policy to take due precautionary measures against this obnoxious prolixity?—RICHARD ASHER: Making Sense. *The Lancet*, September 19, 1959.

Treatment of Extrapyramidal Reactions to Phenothiazine Derivatives

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SINCE THE INTRODUCTION of chlorpromazine in 1951 many new phenothiazine derivatives have been made available, with narrower therapeutic spectrums, higher potencies, and varying side effects or toxic manifestations. These drugs have found wide application both as antiemetics and as ataractics. They are used on an outpatient or home basis as tranquilizing agents and to control the nausea and vomiting of pregnancy and the vomiting of acute gastroenteritis and acute febrile illnesses. Extrapyramidal symptoms (neuromuscular reactions) have been reported with chlorpromazine, perphenazine, trifluopromazine, and prochlorperazine.[1–20] All age groups are susceptible to the development of these toxic symptoms, which may be seen even with low doses well in the therapeutic range.

CASE REPORTS

CASE 1. A 19-year-old white housewife, gravida 1, para 0, was brought into the emergency room of this hospital complaining of a stiff back and neck and abnormal muscular movements that had been increasing in severity for the last few hours. When seen here, all her vital signs and laboratory tests were within normal limits, but she was extremely apprehensive and exhibited opisthotonos, carpopedal spasm, trismus with some protrusion of the tongue, and oculogyric crisis. When questioned, her husband stated that she had been on prochlorperazine extended-action capsules, one 15-mg capsule twice daily for 3½ days. After sedation with phenobarbital, 65 mg orally, she was put to bed. In the morning she was normal both objectively and subjectively.

CASE 2. A 20-year-old white youth, admitted to the hospital with a diagnosis of gastroenteritis, was put on bed rest, 15 mg of propantheline bromide 3 times a day, and 10 mg of prochlorperazine maleate 3 times a day. On the evening of the third day the patient complained of respiratory distress, became apprehensive,

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and had a respiratory rate of 32 per minute. Believing this to be an allergic reaction, a nurse on duty spontaneously administered 0.5 ml of 1:1,000 epinephrine subcutaneously. When the physician saw him, the patient had torticollis, respiratory distress of mild degree, and carpal spasm, and could speak only with difficulty and in a whisper. No medication was ordered, prochlorperazine was discontinued, and oxygen and a tracheostomy set were ordered to be available. One hour later the patient exhibited carpopedal spasm, opisthotonos, torticollis, oculogyric crisis, trismus, aphonia, extreme apprehension, and a respiratory rate of 44. No antiparkinsonian drugs were available, but 1 gram of a trial sample of injectable methocarbamol (Robaxin) was administered intramuscularly with the hope that it would at least ease the laryngeal symptoms. Within 10 minutes the patient was comfortable and talking, and in 20 minutes was completely asymptomatic. There was no recurrence of symptoms.

DISCUSSION

Prochlorperazine may cause toxic symptoms of extrapyramidal tract involvement, such as jitteriness, constant movements, insomnia, muscle spasms, torticollis, opisthotonos, carpopedal spasm, dysphagia, trismus, protrusion of the tongue, oculogyric crises, dysphonia, and tonic seizures. These reactions are usually not dangerous and are reversible. Upon withdrawal of the drug symptoms subside in from 4 to 48 hours. In one reported case symptoms lasted for more than 3 weeks after the medication was discontinued.[12]

The patient's apprehension is appreciable and should be treated with sedation and reassurance. Sedation with barbiturates alone often produces alleviation of symptoms. In more severe cases, antiparkinsonian drugs (e.g., cycrimine hydrochloride, procyclidine hydrochloride, benztropine methanesulfonate, or trihexyphenidyl hydrochloride) are useful. One author [3] states that with the use of benztropine to control these symptoms, administration of phenothiazine can be continued—a practice open to question. These agents do not always produce a rapid response, however.[16] They have also not been available in parenteral form, and patients with trismus, dysphagia, or protusion of the tongue may not be able to swallow them. Recently, a parenteral preparation of benztropine (Cogentin) methanesulfonate was put on the market for the treatment of extrapyramidal symptoms caused by phenothiazines.

When we administered methocarbamol to our patient, we were not aware of its previous use in this condition. It was tried on the basis of its muscle-relaxing effect, brought about by depressing polysynaptic reflexes at the spinal internuncial neurons. It has no direct effect on motor nerves, skeletal muscle cells, or myoneural junctions. Basic monosynaptic reflexes are also unaffected by methocarbamol.[21] Pharmacologically, it "antagonizes" strychnine- and pentylenetetrazol-

induced convulsions. It probably also has some higher central nervous system action, since it prolongs the sleep of animals given hexobarbital and to some extent protects against electroshock. It has been used in paralysis agitans with conflicting results. It has also been used as an adjunct to control systemic tetanus.[22] Correspondence with the manufacturers of methocarbamol indicates that the parenteral preparation has been tried in 10 unreported cases of phenothiazine toxicity, with good results in 5 patients. The manufacturers of Compazine (prochlorperazine) indicate, in their correspondence, good results in 3 of 5 patients treated with methocarbamol for relief of extrapyramidal symptoms. One of these successfully treated cases has been reported.[23] The polyethylene glycol base of the parenteral form of methocarbamol may cause some local irritation on injection and the preparation should therefore be given deep intramuscularly, 5 ml (500 mg) in each of 2 sites. It can also be used intravenously if deemed necessary.

Curare has been employed in similar cases of phenothiazine toxicity,[16] but of course its use necessitates a means of assisting or controlling ventilation and constant attendance by a physician. Caffeine sodium benzoate has also been used to control these neuromuscular reactions in children, 0.5 gram being given intravenously.[24]

It is probable that the incidence of reactions from phenothiazine derivatives could be decreased if the dosage were meticulously individualized and if the drugs were used only when definitely indicated. The indications for the use of prochlorperazine and other ataractic agents are often indefinite and may be too liberal. Since these drugs are potent and since side effects inherent in their primary action may sometimes be dangerous, they should be administered only if the patient's symptoms really warrant pharmacologic intervention and only if there are no safer drugs available. In the 2 cases reported here, the use of prochlorperazine cannot be completely justified. The symptoms of gastroenteritis may be effectively treated with antispasmodics, and routine use of phenothiazine derivatives for the nausea and vomiting of pregnancy should not be condoned. The diagnosis of surgical conditions of the abdomen may be impeded by these drugs. When they are used to depress nausea and vomiting caused by other agents, they may mask toxic overdosage of the latter. Patients on phenothiazine derivatives should be cautioned to discontinue their use with the first sign of extrapyramidal or other toxic symptoms.

SUMMARY

Toxicity to prochlorperazine, manifested by severe extrapyramidal symptoms, occurred in 2 adults. One patient was treated with

sedation; symptoms disappeared in 8 hours. Because of respiratory distress, the second patient was treated with methocarbamol intramuscularly, with dramatic results. The treatment of the neuromuscular symptoms of phenothiazine toxicity is discussed.

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REVIEW OF THE LITERATURE

One of the most useful types of medical articles is the comprehensive review of the literature but its value is directly proportional to the amount of time and effort that go into its preparation. By bringing order out of chaos, it provides a solid foundation upon which more secure knowledge can be added. . . . Almost anyone can collect material from the literature and set it down in reportorial fashion, but rare indeed is the literary artist who can select the appropriate pieces of the jigsaw puzzle and fit them together so that they form a picture that has definite meaning and design. The effective review of the literature is truly a work of the artist; there is a strong need for this type of article in our medical literature to bridge the gap between what is known about a controversial subject or obscure disease and what remains to be investigated.—SELMA DEBAKEY: Some Types of Medical Papers. *Southern Medical Journal*, December 1959.

Pregnancy in Double Uterus

Report of Three Cases

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THE OCCASIONAL FAILURE of the müllerian ducts to fuse during embryologic development gives rise to a series of anomalies ranging from partial to complete duplication of the uterus, the final result depending, of course, on the stage reached before the premature arrest of the fusion process. The true incidence of pregnancies occurring in the malformed uterus is not known since few cases have been recognized at any single institution. Probably some instances of pregnancy in an anomalous uterus escape detection because labor and delivery are normal. A survey of the literature [1–8] failed to reveal any more recent statistics than those of Smith,[1] who in 1931, after a review of 141,946 consecutive pregnancies, concluded that "the probable frequency of occurrence of pregnancy in double uteri is about 1 in 1,500 cases." In view of this relative infrequency, I would like to report 3 cases observed during a 3-month interval in a relatively small obstetric department that ordinarily handles from 20 to 25 deliveries a month.

CASE REPORTS

CASE 1. A 17-year-old woman, para 0–0–1–0, was first seen at the prenatal clinic of this hospital in October 1958, during the thirty-first week of her pregnancy. Review of the history indicated that the patient's menarche occurred at the age of 11 and that her menses were regular, recurring every 28 to 30 days and lasting 5 to 6 days.

In 1957 the patient had had a spontaneous, complete 12-week abortion, which was not followed by curettage. At that time her physician informed her that she had a "separation" in her vagina. She was admitted to Carswell Air Force

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Base Hospital in March 1958 for excision of the vaginal septum. Examination under anesthesia at that time revealed that in addition to the midline vaginal septum, the patient had 2 separate uterine bodies joined in the supracervical areas and 2 cervices. Hysterosalpingography was planned, but when the patient returned to the clinic 6 weeks after septal resection, an early pregnancy was felt in the left cornu. The first day of her last menstrual period was given as 26 March 1958 (2 days after the septal excision) and her expected date of confinement was calculated to be 1 January 1959. She was seen at 4-week intervals from March until September, and the hospital records indicate that she had an uneventful pregnancy throughout this period.

When we saw this patient in October, we were unable to discern any gestational abnormalities. On 15 November, during the thirty-third week of pregnancy, the patient was admitted to the labor room in active premature labor. The first stage was uncomplicated, the cervix becoming fully dilated within 3 hours after onset of labor, and a living 1,688 gram male infant, in excellent condition, was delivered spontaneously over a left mediolateral episiotomy. The placenta was delivered spontaneously and the patient had only an average amount of blood loss during the third stage. The mother was discharged from the hospital 5 days post partum; because of prematurity, the infant was discharged 4 weeks later.

Following delivery, the patient's first menstrual period occurred in January 1959. She reported to the prenatal clinic in April and the diagnosis of a 10-week intrauterine gestation was made. The patient had an uncomplicated pregnancy, and a 2,200-gram living female infant was delivered on 16 September in the thirty-sixth week of gestation.

CASE 2. A 27-year-old woman, para 0–0–1–0, was first seen at the prenatal clinic of this hospital in July 1958. Her menarche reportedly occurred at the age of 17, her menses recurring every 30 days and lasting 8 to 9 days, with no irregularities at any time. In 1956, the patient had had a spontaneous, complete 16-week abortion and was informed at that time that she had a "double uterus." Curettage was not performed following the abortion.

The last menstrual period was stated as having begun on 1 April 1958 and the expected date of confinement was calculated as 8 January 1959. On examination, a vaginal septum was noted, with a soft bluish cervix at the upper end of each vaginal compartment. The uterus appeared to be enlarged to the size of a 12-week gestation, but although there was a suggestion of 2 uterine cornua, they were not clearly delineable. The patient's prenatal course was complicated by episodes of vaginal spotting in July and August as well as by frequent complaints of generalized abdominal discomfort. The pregnancy was uneventful in all other aspects except that the fetus assumed a breech presentation in the thirty-fourth week.

On 13 December, during the thirty-seventh week of gestation, labor began. Abdominal examination revealed that the baby was in a right oblique presentation; its weight was estimated at 2,800 grams. Sterile vaginal examination revealed that the right cervix was dilated to 2 cm, with the breech at station minus three and the membranes intact. In view of the abnormal presentation superimposed on the uterine anomaly, it was decided to effect delivery by cesarean section. At laparotomy, the uterus was noted to be a single external organ with an indentation in the fundus and an internal septum dividing it into 2 separate compartments. A 2,700-gram living female was delivered from the right cornu by low cervical cesarean section. The mother's postpartum course was uneventful and

she was discharged from the hospital 7 days postoperatively. The infant did well for 4 days but developed diarrhea on the fifth day and died 2 days later after a stormy course. The postmortem examination revealed interstitial pneumonitis and congestion of the intestinal mucosa.

The patient had normal menstrual periods in January and February and visited the prenatal clinic in May, at which time it was noted that she had an 8-week intrauterine gestation. The present prenatal course has been uneventful except for the fact that at 32 weeks the fetus is in a breech presentation.

CASE 3. A 38-year-old woman, para 6–2–1–7, was first seen in the prenatal clinic of this hospital in July 1958. The patient stated that her menarche had occurred at the age of 12 and that her menses recurred every 26 to 28 days, lasting 5 to 7 days, with no abnormalities at any time.

At the time of her first pregnancy in 1937 she had been informed that she had a double uterus. Her past obstetric history included the following 9 pregnancies:

1937—Spontaneous vertex delivery of living 3,650-gram female at term.
1939—Spontaneous vertex delivery of living 3,700-gram male at term.
1940—Spontaneous vertex delivery of stillborn premature infant at 28 weeks.
1941—Assisted breech delivery of 3,250-gram living male at term.
1943—Assisted breech delivery of 3,450-gram living male at term.
1946—Incomplete abortion, followed by curettage, at 10 weeks.
1950—Assisted breech delivery of living 2,150-gram male at 28 weeks.
1953—Assisted breech delivery of living 2,900-gram male at term.
1956—Assisted breech delivery of living 3,000-gram female at term.

The patient's last menstrual period had begun on 14 May 1958 and her expected date of confinement was calculated to be 21 February 1959. On examination, the vagina and cervix were perfectly normal, but a deep indentation was noted at the superior pole of the uterine fundus and the organ was enlarged to a size compatible with a 10-week gestation. The prenatal course was marked by hospitalization for vaginal bleeding during the twelfth week. The patient had vaginal spotting for 17 days, but she did not abort, and the remainder of her pregnancy was totally uneventful.

On 5 February 1959, at the beginning of the thirty-eighth week of gestation, the patient was admitted to the hospital in active labor. Labor progressed well and was terminated with a low-forceps delivery of a living 2,800-gram female in excellent condition. The placenta was delivered spontaneously and the third stage of labor was accompanied by only the average amount of bleeding. The uterine indentation noted during the patient's first visit was felt even more prominently immediately post partum, when the uterus assumed a pronounced heart shape. The mother and infant were discharged in good condition 5 days after delivery.

This patient has not become pregnant since her last delivery, and a hysterosalpingogram demonstrating her uterine anomaly was obtained when she visited the gynecology clinic to ask for tubal ligation.

DISCUSSION

Eastman [2] states that although a bicornuate uterus does not interfere with conception, it predisposes to abortion and premature labor. According to Falls,[3] the abnormal circulation, musculature, and

innervation of the incompletely fused uterus lead to abnormal decidual reaction and consequent abnormal placental formation and are etiologic factors responsible for a high incidence of abortions. Falls [3] also discusses the most frequent complications to be anticipated if the patient overcomes her tendency to abort, such as premature labor, intrauterine fetal asphyxia, breech presentation, fetal opisthotonos, oblique presentation, placenta previa, prolapsed cord, postpartum hemorrhage, and retained placenta.

Jones and associates [4] recently conducted a study to determine the factors responsible for fetal wastage in pregnancies occurring in the incompletely fused uterus, and to assess the value of medical and surgical interference in these women. They found that although the majority of patients had enjoyed "successful reproduction," one third suffered losses because of abortions, premature deliveries, and full-term stillbirths. Fetal malpresentation was found to be the major factor responsible for the term losses, and it was concluded that the elimination of fetal loss at term depends upon recognition of the malpresentation, knowledge that the uterine anomaly is present, and realization that this combination necessitates careful obstetric management. Investigation of the patients who were classified as habitual aborters, on the basis of having had 3 or more consecutive abortions, revealed that many had coexistent endocrine and metabolic disorders. Endocrine therapy was highly successful in this group of women, so that the investigators considered the uterine malformation to be of minor consequence in this situation. A modified Strassmann reconstruction was performed in 10 patients who had had 3 or more consecutive abortions with no term deliveries and no discoverable extrauterine etiologic factors to account for the recurrent abortions. Although living term infants were delivered, the authors warn that too few operations for habitual abortions have been recorded in the literature to permit any statistical evaluation of the worth of these procedures.

Each of the 2 patients with uterus didelphys dicollis and the patient with uterus bicornis unicollis presented here had one or more of the complications mentioned by Falls.[3] One patient had 2 premature deliveries and 5 breech presentations, another went into premature labor on 2 occasions, and another had an oblique breech presentation. Fortunately, we did not encounter any serious hemorrhagic difficulties. The ease of conception is well illustrated by the short time interval between delivery and subsequent conception in the first 2 patients, as well as the grand multiparity of the third patient. The gestations described here illustrate Jones and associates' [4] finding that the majority of these women have few reproductive difficulties.

SUMMARY

Because the incidence of pregnancies in incompletely fused uteri is only about 1 in 1,500 cases, it was considered most interesting to observe 3 such cases over a 3-month period in a relatively small obstetric department. These cases are presented in detail. Some of the most frequent complications of pregnancy in an anomalous uterus, namely abortions, premature labors, and breech presentations, occurred in these patients. Other complications, such as intrauterine fetal asphyxia, fetal opisthotonos, placenta previa, prolapsed cord, postpartum hemorrhage, and retained placenta, were not observed. Although "successful reproduction" is enjoyed by the majority of patients with incompletely fused uterus, those that manifest reproductive difficulties in the nature of repeated abortions must be thoroughly investigated for the usual etiologic factors before surgical unification of their uterine anomalies is considered.

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PHYSICIAN, HEAL THYSELF

> Do not imitate those unskillful physicians who profess to possess the healing art in the diseases of others, but are unable to cure themselves.—Sulpicius

Clinicopathologic Conference

History of Atypical Pneumonia

U.S. Naval Hospital
Key West, Florida

A 37-YEAR-OLD WHITE MAN was admitted to this hospital on 24 May 1958. He had previously been hospitalized for atypical pneumonia in February, when a test for cold agglutinins was reported as positive in a dilution of 1:2,048. Roentgenographic evidence of clearing of the pneumonic process occurred before his discharge in mid-March. The patient was completely asymptomatic until the first part of May, when he began to have productive cough, progressive nocturnal and exertional dyspnea, weakness, pedal edema, and nocturia, together with anorexia and weight loss of 10 pounds in a 2-week period. The day before admission he began to vomit and was unable to retain any solid food. By this time he was unable to walk even a few hundred feet without becoming markedly dyspenic. He had had to sleep in a chair because of orthopnea. He denied any chest pain, hemoptysis, hematuria, arthritis, skin rashes, abdominal pain, or epistaxis.

Physical Examination

The patient was pale and had purplish blotchy cyanosis. Moderate orthopnea and minimal dyspnea at rest were present. The blood pressure was 106/78 mm Hg, weight 168 lb, temperature 8.6 F, pulse rate 84. There were rales at the bases of both lungs, the heart was enlarged to percussion, and auricular fibrillation was noted. The second aortic and pulmonic sounds were equal. An apical systolic murmur was heard, but no thrills, gallops, or rubs were observed. The liver was palpable 6 fingerbreadths below the right costal margin and slightly tender. The spleen and kidneys were not palpable. There were no masses or ascitic fluid, but 3 plus edema of both legs and thighs and moderate neck vein distention were noted.

From the Medical Service, U.S. Naval Hospital, Key West, Fla. Capt. Leslie D. Ekvall, MC, USN, is commanding officer.

The venous pressure on admission was 280 mm of water. The arm to lung time was 7 seconds, arm to tongue time 15 seconds.

Laboratory Studies

On admission sputum culture and urinalysis were negative. A sulfobromophthalein (Bromsulphalein) test showed 25 percent dye retention. The serum bilirubin was 2.5 mg. Thymol turbidity, serum proteins and fractional proteins, complete blood count, and test for heterophil agglutinins were normal. The level of prothrombin activity was 70 percent. Electrolytes were within normal limits. The erythrocyte sedimentation rate was 12 mm per hour.

Approximately one month after admission, with congestive failure clearing on therapy, the serum bilirubin was normal. The urinalysis, blood count, and sedimentation rate remained normal. Serum amylase as well as repeated tests for heterophil and febrile agglutinins were within normal limits. In July, slightly more than 1 month before death, there was 12 percent retention of Bromsulphalein. Sputum smears and cultures and gastric cultures were negative for acid-fast bacilli, and the serum electrolytes and blood urea nitrogen remained within normal limits. The chest roentgenogram showed no acute pneumonic process, but some pleural thickening at the base of the left lung.

Course in Hospital

The patient was treated with low-sodium diet, mercaptomerin (Thiomerin) sodium, digitalization, and night sedation. Gradual loss of weight occurred and the patient became essentially free of congestive heart failure 5 weeks after admission. The cardiac size did not change appreciably however, although the rhythm converted to sinus arrhythmia with first-degree heart block. A pericardial thoracentesis was performed, but no fluid was obtained.

During the patient's hospital course he developed numerous attacks of right upper quadrant, left lower quadrant, and flank pain, transient in nature. Hematuria was never in evidence. One week before death the patient had a small episode of hemoptysis, but a chest x-ray at that time did not show any parenchymal pulmonary disease.

Freedom from congestive failure lasted for about 2 weeks, after which gradually increasing pedal edema, orthopnea, dyspnea, and hepatomegaly failed to respond to digitalis, mercurial diuretics, acetazolamide (Diamox), ammonium chloride, oxygen, bed rest, and low-sodium diet. Diuresis failed to ensue when a dose of 15 mg

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of prednisolone (Meticortelone) every 6 hours was abruptly discontinued after 10 days. Immediately after this, the patient went home on liberty, where he collapsed. He was brought to the emergency room and pronounced dead by the officer-of-the-day on 31 August.

DISCUSSION

DR. JONES:* This 37-year-old man was first hospitalized in February for an atypical pneumonia, when a cold agglutinin test was positive in a dilution of 1:2,048. Although this is a good test for atypical pneumonia, it isn't diagnostic in more than one-half the cases. Other conditions in which we find elevated cold agglutinins are acquired hemolytic anemias, cirrhosis and other liver conditions, leishmaniasis, blackwater fever, and chronic sepsis, which I'm sure he did not have. I'd like to see the x-rays of the atypical pneumonia.

DR. PARMELEE:** The first chest x-ray (fig. 1) on this patient on 11 February 1958 shows evidence of a peribronchial pneumonia involving the lower lobe of the left lung posteriorly, with minimal associated pleural reaction. There is an old calcified Ghon primary complex in the midzone of the right lung. The last film on 24 February shows the pneumonic process to be essentially resolved, with a minimal pleural scar still present in the left chest laterally. It is my feeling that there was no particular cardiac abnormality, and that this was purely a pneumonic process.

DR. JONES: Thank you. Then we have this patient discharged in mid-March apparently well, completely asymptomatic until the first part of May of the same year, when he is hospitalized with a history of atypical pneumonia and signs of congestive failure. On admission he had an elevated venous pressure with a normal circulation time, which makes one think that maybe this is a case of high-output failure. Conditions in which you may see high-output failure are anemia, which he didn't have; hyperthyroidism; beriberi heart disease; Paget's disease; pulmonary emphysema; and arteriovenous fistulas anywhere in the body. I don't know quite what to make of the circulation time unless there is a mistake in technic. Anyway, he responded to treatment and became essentially free of congestive failure 5 weeks after admission. However, his cardiac signs did not change appreciably, although his rhythm converted to a sinus arrhythmia with a first-

*Lt. Paul K. Jones, MC, USNR, ward medical officer, medical service.
**Comdr. Kenneth A. Parmelee, MC, USN, radiologist.

Figure 1. Roentgenogram of chest on 11 February 1958 shows pneumonic infiltration in lower lobe of left lung, with minimal pleural reaction. Note calcified primary complex in hilar region of right lung.

degree heart block. The block could have been on the basis of digitalis administration or on the basis of his heart disease alone. He then remained free of congestive failure for about 2 weeks, after which his failure gradually increased in severity and no longer responded to any therapy. Steroids to institute diuresis were tried as a last resort and without success. Progressive unrelenting congestive failure ended in sudden death.

The laboratory work doesn't help much. The 25 percent Bromsulphalein retention is to be expected in anyone with chronic heart failure. The abnormal liver tests also reflect congestive failure and improved during therapy. The chest x-ray showed pleural thickening at the base of the left lung, probably a residual of the atypical pneumonia. Will Dr. Parmelee comment on the x-rays?

DR. PARMELEE: I fluoroscoped the patient on 27 May. The lung fields were essentially clear and hilar shadows were not remarkable. There was no evidence of congestive failure. The findings of note were a rather markedly enlarged heart, evidence of enlargement of

both ventricles, a fair degree of left ventricular hypertrophy, and some fulness of the right ventricle. The cardiac pulsations themselves were diminished. I felt very strongly that this patient had a pericardial effusion. Repeated chest x-rays in June and August failed to show any significant change in the cardiac size.

DR. JONES: Thank you. It is interesting to note that we don't see the prominent pulmonary congestion that one would expect with the degree of congestive failure described. Now, for the electrocardiograms (figs. 2 and 3). The tracing of 24 May (fig. 2) shows fibrillation. I don't see any good R waves in V_2, V_3, or V_4. This could be compatible with an old anteroseptal myocardial infarction. On the second tracing made 3 days before death (fig. 3) the patient has gone back into normal sinus rhythm with first-degree heart block and there are numerous multifocal premature ventricular contractions. To me this tracing could be compatible with an anterior septal myocardial infarction, although this has not been mentioned in the protocol. I can't determine whether there is any R voltage in the right precordial leads. The patient's attacks of flank and abdominal pain may have been embolic phenomena to different organs, the liver and spleen particularly, since we could reasonably expect hematuria with renal infarcts. Whether he also had a pulmonary embolus to explain the episode of hemoptysis is hard to say; that would be very likely in a patient in chronic congestive heart failure.

I'm faced with a man who is 37 years old, an age at which he could have any type of heart disease—rheumatic, arteriosclerotic, or any of the so-called myocarditides. Now, to discuss some of the things that I would consider in this man, realizing that this is a CPC and the obvious diagnosis is occasionally the correct diagnosis. My first thought is that he may have had arteriosclerotic heart disease and a myocardial infarct, with subsequent pulmonary emboli, and either he threw a large pulmonary embolus at the end or else had another myocardial infarct that caused his sudden death.

That fits—but I don't think that's the case. There are many different conditions that can give a picture like this. I believe this man had myocarditis. Now, many different things can cause myocarditis. All the infectious diseases—influenza, mild respiratory diseases, even scarlet fever, pneumococcic pneumonia, and others. We note that he had, apparently, atypical pneumonia on his first admission. We find minor ST and T wave changes in atypical pneumonia in a small percentage of the cases. The disease is usually transient. I've never heard of a case progressing as this one did.

Another diagnosis that could be considered is sarcoidosis primarily

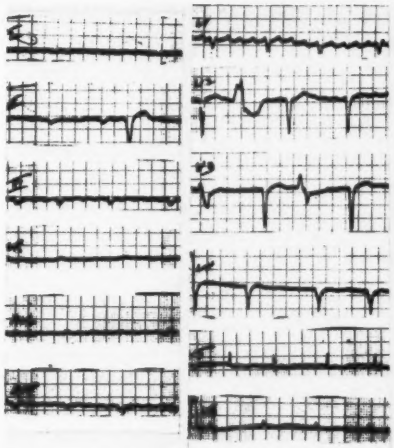

Figure 2 (left). Electrocardiogram of 24 May shows auricular fibrillation and low or absent R waves in V_2, V_3, and V_4.

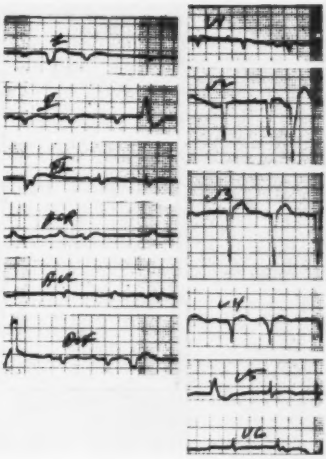

Figure 3 (right). Tracing of 28 August shows return to normal sinus rhythm and numerous multifocal premature ventricular contractions.

involving the heart. We have no evidence of sarcoid. Another possibility is scleroderma. Sometimes scleroderma involves the heart before it involves the skin or subcutaneous tissue or the esophagus. Again we have no evidence of this. Periarteritis involves the heart; so does lupus. In periarteritis, there is usually hypertension and sometimes eosinophilia. This man did not have hypertension and there's nothing to make me suspicious of periarteritis. It's hard to say whether he had a rheumatic myocarditis. In the face of an afebrile course, however, a near normal sedimentation rate, a normal white count, and no involvement of his joints, I doubt that he had rheumatic myocarditis, and I think that the doctors who were taking care of him didn't consider that either because he did not have a trial of salicylates. Syphilis, hemochromatosis, Reiter's disease, and leptospirosis all might be mentioned as possibilities.

In some myocarditides even the pathologists can't make up their minds to a label. One of these conditions is called idiopathic hypertrophy of the heart. It occurs in adults and it also has been called endocardial fibroelastosis. It is endocardial fibrosis with degenerative and necrotic myocardial changes. These people get large hearts, have pulmonary emboli, and usually die. Another condition is pri-

mary amyloidosis, which usually involves the skin, the lung, and the heart and skeletal muscle also. It is a difficult diagnosis, can be made on a gingival biopsy, but first you have to think of it and there's nothing here to give a lead. In amyloidosis a large heart and atrial fibrillation may be seen.

My primary diagnosis on this gentleman is Fiedler's myocarditis. Fiedler's myocarditis occurs usually in the third decade. This man is a little old for this, but there are some cases reported all through life. Usually, these people have an antecedent history of an upper respiratory infection or concurrent respiratory infection. This would fit with our case. The etiology of Fiedler's myocarditis is unknown. Some people think it's a virus, others postulate a bacterial toxin, and still others think it's an allergic reaction; and the reason I inquire about the treatment of his atypical pneumonia is that some people feel that it's an allergy to penicillin or sulfonamides. Nobody knows. The heart is usually dilated and hypertrophied and there is widespread inflammatory infiltration of the myocardium. The onset may be gradual or acute. There may be emboli to the lungs and to the brain. We expect a downhill progressive course. I have been asked to make a first choice, and my first choice is Fiedler's myocarditis, and my second choice is amyloidosis. Third choice is idiopathic hypertrophy and fourth choice is arteriosclerotic heart disease with myocardial infarction.

DR. RULON:* Dr. Jones, thanks for taking a firm stand on one diagnosis. Relative to your discussion, I think the circulation times as recorded on the chart must be regarded with some suspicion. As far as I know the steroids were given purely as a last-ditch attempt to promote diuresis rather than as a specific therapeutic measure. In this laboratory we regard a corrected 10-mm sedimentation rate as the upper limit of normal in the male. This test is subject to error: Improper amounts of anticoagulant or a slight slant of the tube during reading can give a misleading result. I would consider 12 mm as a borderline.

DR. CLARK:** I was asked to review this case and came to the same conclusion as Dr. Jones did. My first diagnosis also favors myocarditis.

DR. JONES'S DIAGNOSIS:
Fiedler's myocarditis

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*Comdr. David B. Rulon, MC, USN, pathologist.
**Lt. Donald W. Clark, MC, USNR, ward medical officer, medical service.

DR. RULON: I'd like to invite any comments from the floor before we go into the autopsy findings.

DR. SHUPTAR:* Were any viral studies done?

DR. RULON: Unfortunately, no. Nothing other than the cold agglutinins at the time of the pneumonia and this would not be termed a specific viral study. The diagnosis of myocarditis was shared by the physician who took care of the patient.

PATHOLOGIC FINDINGS

DR. RULON: This man died rather suddenly of congestive cardiac failure. His liver was large, weighing 1,800 grams. The edges were rounded and the cut sections showed the usual nutmeg pattern of chronic passive congestion. There was also extreme congestion around the central veins, with central necrosis of liver cells, so I agree that abnormalities of his liver function test were on the basis of congestive failure. There was other evidence of congestive failure. The lungs were edematous, congested, and heavy. The right lung weighed 750 grams, the left 550. The Ghon tubercle that Dr. Parmelee showed you was present and in addition there were pleural adhesions and a small infarct at the base of the left lung. Generalized visceral congestion and some dilatation of the chambers of the heart lend good anatomic support to the diagnosis of acute congestive failure for the terminal episode.

The heart weighed 525 grams and there was 5 ml of pericardial fluid. The myocardium was pale, flabby, friable, and bulged above the cut surface. The coronaries showed general pipe-stem rigidity throughout, and a partially occlusive arteriosclerotic plaque was present in the main branch of the left coronary artery about 1 cm proximal to the first bifurcation. With no recanalization and no thrombus there was no evidence that there had been a complete occlusion at any previous time. The endocardium was thickened and opaque here and there, particularly noticeable in the left ventricle immediately below the aortic valve. Mural thrombi were present in 3 chambers of the heart: the left ventricle and both auricular appendages. One embolus was demonstrated. It was in a branch of the pulmonary artery about 4 cm from the 3-cm infarct in the lower lobe of the left lung. In reference to the abdominal pain, there were splenic and also renal infarcts. With the renal infarcts, one would normally expect hematuria. Its absence in this case may be related to prolonged

*Lt. Daniel Shuptar, MC, USN, pediatrician.

Figure 4. Section from posterior wall of left ventricle shows extensive interstitial fibrosis. Similar widespread changes were seen throughout both ventricles, not localized to any area of coronary distribution. (x 133)

standing of the urine prior to examination; red cells disappear rapidly, especially in acid urine, or in urine of low specific gravity.

Sections of myocardium from various areas of both atria and ven-

Figure 5. Left coronary artery is partially occluded by an arteriosclerotic plaque. (x 47)

tricles showed essentially the same microscopic picture, of extensive interstitial fibrosis. The mural thrombus adjacent to the left ventricular wall was demonstrated, and at this site inflammatory infiltrate was seen in the adjacent myocardium. Fibrosis was seen in sections taken from the region of the auriculoventricular node, and throughout both ventricles (fig. 4). The atherosclerotic plaque in the left main coronary artery was also demonstrated (fig. 5). This lesion may have aided the progress of the myocardial fibrosis. I believe that this widespread change, not localized to the anterior septal area or to any area of coronary distribution, is incompatible with almost any diagnosis except healed myocarditis, where there has been a diffuse inflammatory change in the heart, some residual inflammatory foci, and widespread fibrosis resulting in a relatively inflexible organ. Etiologically, the origin of this myocardial fibrosis is obscure, but we choose to relate it to myocarditis, secondary to atypical pneumonia.

PATHOLOGIC DIAGNOSIS:

Diffuse myocardial fibrosis, due, presumably, to myocarditis following atypical pneumonia.

INDICATIONS FOR SURGERY

Operations carried out solely for the relief of symptoms without rectifying in any way the underlying cause of those symptoms have never been widely practised by British surgeons. With the exception of procedures to alleviate the misery of advanced malignant disease, purely symptomatic surgery tends to be regarded as quackery, and those who practise it to be relegated to the fringe of, if not well within, the underworld of surgery. It is illogical, however, to deny a patient relief of his discomfort simply because the underlying cause is either unknown or impossible to rectify.—A. M. BOYD and K. BLOOR: Results of Tenotomy of the Tendo Achillis in Intermittent Claudication. *British Medical Journal*, February 20, 1960.

Use of a Porous Synthetic Sponge (Ivalon) in Surgery II. Studies of Tensile Strength

RICHARD H. ADLER, M.D.
CLEMENT DARBY, M.D.

DESPITE THE WIDESPREAD CLINICAL USE of Ivalon, broad differences of opinion exist concerning its value in surgery. At the onset of this study we reasoned that part of this variance may have been due to insufficient attention paid to the fabrication of the Ivalon prosthesis and to the function to which it was subjected. Certainly, the stress imposed upon an Ivalon prosthesis serving as a common bile duct or segment of trachea will be different from that imposed upon a prosthesis used to replace a segment of aorta or to reinforce a ventral hernia. One would speculate that the more highly compressed sponge prosthesis would have greater strength and be more desirable when it must serve under conditions of pressure and stress.

A review of the literature revealed that Ivalon sponge has been used in a great variety of thicknesses and in forms that ranged from uncompressed prostheses to multiple superimposed layers compressed at random without specific calculation in regard to the function to which the prosthesis was to be subjected.

There appeared to be a definite need to study more carefully the method of fabrication and degree of compression from the aspect of the effects of these factors upon the tensile strength of the prosthesis. It seemed essential that more exact knowledge of the ultimate tensile strength of Ivalon following in vivo implantation should be known if the sponge is to be subjected to the environments of continued stress.

This section of the study deals with tensile strength determinations made upon sponge samples subjected to accurately controlled ratios of

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From Buffalo General Hospital and the Department of Surgery, University of Buffalo School of Medicine, Buffalo, N.Y. Supported by the Research and Development Division, Office of the Surgeon General, Department of the Army, under Contract No. DA-49-007-MD-750. Part I of this study, "Tissue Responses After Implantation," appeared in the November issue of the *Journal*.

compression under in vitro and simulated in vivo conditions. Certain practical applications derived from these observations will be discussed.

MATERIALS AND METHODS

Tensile Testing

All Ivalon specimens subjected to tensile testing were accurately fashioned to a standard test size that allowed for a section of sponge 2 inches long, 1 inch wide, and either 1 or 2 mm thick. This would be large enough to minimize differences due to irregular initial porosity. The specimens were actually longer than 2 inches in order to allow surface for gripping by the jaws of the tensile testing apparatus. The final pre-testing width of 1 inch was cut with a special double-bladed slicer. The method of compression has been described in part I.[1]

All tensile tests were carried out on an Instron tensile testing apparatus, which was made available to us by the testing laboratories of a local industrial concern. This machine is a semiautomatic, highly sensitive weighing system that employs bonded-wire strain gages to detect and record the load applied to a sample under test (fig. 1A). The standard-size Ivalon specimen was placed between the fixed upper jaw and the lower pulling jaw (fig. 1B). The initial distance between the 2 jaws was 2 inches. As the jaws separated during a tensile test, a continuous record of load on the test piece versus strain or elongation of the piece was traced synchronously on a recorder chart to the point of rupture. Figure 1C shows a standard test piece of Ivalon during actual measurement. The specimen has been elongated by about 150 percent of its original length of 2 inches and is nearing the point of rupture.

The final tensile strength was based on nominal dimensions of the test piece, that is 2 inches long, 1 inch wide, and 1 or 2 mm thick. During elongation of the 2-inch dimension, the specimen "necks down" in such a way that at the point of rupture, the width and thickness of the piece are considerably less than at the beginning of elongation (fig. 1C). The final calculated tensile strength—or nominal tensile strength—was therefore based on the known cross-sectional area of the piece at the beginning of the elongation. Had the tensile strength been based on the cross-sectional area at the point of rupture of the test piece, this would have been reported as true tensile strength and would have had a value considerably higher than the nominal tensile strength. Nominal tensile strength is valid for comparison

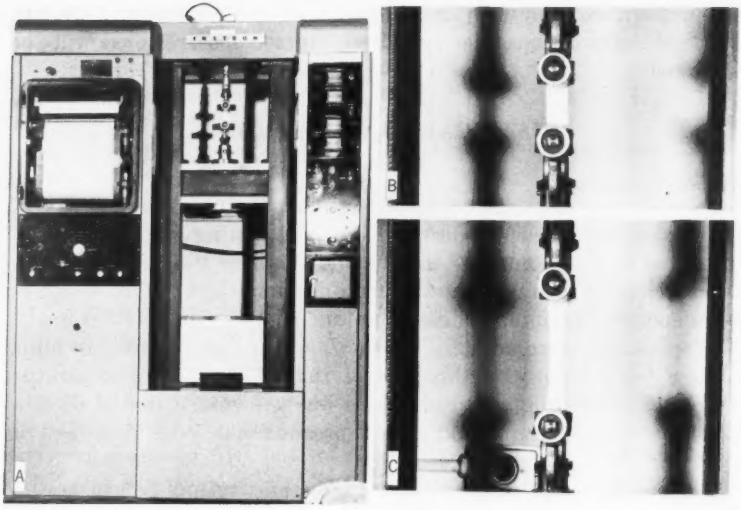

Figure 1. Instron tensile testing apparatus. (A) Front view, showing recording chart to left and jaws containing Ivalon test piece in upper center. (B) Close-up photograph of jaws, with test piece of Ivalon in place. (C) Jaws moving apart, showing stretch and "necking down" of same Ivalon test piece.

purposes and is commonly used where the cross-sectional area of the test piece at break is unknown. The rate of elongation during the testing of all pieces was held constant at 100 percent per minute; that is, each test was elongated 2 inches per minute. For each compression ratio tested, 2 or more test specimens were used, and the tensile strength was based on the average load at break.

Tensile strength studies were carried out on the commercially available surgical grade Ivalon and the finer more uniformly porous Ivalon described in part I.[1] These tests were made on untreated, as-received sponge through the complete spectrum of compression ratios at 1- and 2-mm thicknesses. Selected compression ratios with controls were used to study sponges subjected to certain exposures to be described.

In Vivo Studies

Subcutaneous implantation

Originally, fairly large tensile test specimens 1 and 2 mm thick were implanted subcutaneously on the abdominal wall of rabbits. Speci-

mens of surgical grade Ivalon were fashioned in compression ratios of 1:1, 2:1, 4:1, 8:1, 16:1; and of fine-grade sponge, in the ratios of 1:1, 2:1, 4:1, and 6:1. These were to have been removed for tensile testing at set intervals up to 1 year. Unfortunately, this attempt at measuring the effects of in vivo implantation of sponge alone was frustrated by the uncontrolled infiltration of fibrous tissue. Nevertheless, control specimens for each thickness in all compression ratios were subjected to comparative tensile testing.

Implantation in Millipore chamber

An attempt was made to expose Ivalon to in vivo environment without uncontrolled fibrous infiltration by enclosing the test specimen between folded Millipore filter paper. Millipore filter paper is a thin cellulosic membrane having about 50 million capillary pores of uniform dimensions per square cm of filter surface. The particular type of Millipore used in these experiments was produced with a nominal pore size of 0.45 micron and a thickness of 150 microns, and backed with a continuous web of monofilament nylon to add strength and support to the membrane. The small-pore size prevents cellular invasion but allows fluid diffusion.

To prepare an Ivalon-containing Millipore chamber, a 4 by 4 inch piece of Millipore paper was folded once upon itself with the nylon backing on the outside. After inserting the standard test piece of Ivalon between the leaves of the folded paper, the edges were sealed with Millipore cement (MF cement). When the cement had dried, the Ivalon-Millipore chamber was soaked in 1:1,000 benzalkonium (Zephiran) chloride solution for 24 hours. Under sterile conditions, 2 of these chambers were implanted in each of 7 dogs through an anterior abdominal midline incision. Each chamber was anchored by corner sutures, one chamber in each lateral intra-abdominal gutter. All specimens were cut from a single block of the finely porous Ivalon at a compression ratio of 4:1 and a thickness of 1 mm. Similar untreated specimens served as controls for the tensile tests. Animals were to be sacrificed at intervals through 1 year.

In Vitro Studies

As an initial estimate of the changes of the properties of Ivalon, in vitro experiments were designed in an attempt to approximate some of the conditions of in vivo tests without introducing the effects of the variable of fibrous ingrowth on the tensile properties of the sponge. Standard-size specimens were prepared from a single block of finely

porous Ivalon. A thickness of 1 mm and a moderate compression ratio of 4:1 were arbitrarily decided upon for use in these tests.

To prepare a standard test specimen, a 4-mm thick section of the dry, uncompressed sponge was cut from the original block on a circular meat slicer. The sheet of cut sponge was cut into standard-size strips and compressed to a final thickness of 1 mm between plywood-reinforced glass, as described in part I.[1] After exposure to the various environments for set periods of time, the specimens were accurately cut to a width of 1 inch by the special double-bladed slicer and then placed in the 2 jaws of the Instron apparatus set 2 inches apart. Thus for each test, the Ivalon specimen was always 2 inches long, 1 inch wide, and 1 mm thick.

In these tests, each of 5 sets of 4 standard test strips was placed in a sterile 500-ml Erlenmeyer flask; 250 ml of human plasma was added to each flask, as well as 400,000 units of penicillin and 0.5 gram of streptomycin. All 5 flasks were sealed under sterile precautions and placed in a darkened incubator at 37° C. One flask was removed from the incubator and the strips tested on the Instron apparatus after 6 weeks. Strips from the other 4 flasks were tested after 3, 6, 9, and 12 months of incubation, respectively.

Two other similar sets of flasks each containing 4 Ivalon strips were prepared and incubated for the same time intervals before tensile testing. The latter 2 sets of flasks differed from the first in that instead of human plasma, 1 set of flasks contained only normal saline and the other saline plus 400,000 units of penicillin and 0.5 gram of streptomycin. As controls for the 3 sets of incubated material, 5 similar strips of Ivalon were tested on the Instron apparatus without exposing them to incubation. All strips, both incubated specimens and the nonincubated controls, had the standard parameters of 2-inch length, 1-inch width, 1-mm thickness, and 4:1-compression ratio.

RESULTS

In Vivo Studies

Subcutaneous implantation

Early in the study, it became apparent that a fibrous capsule frequently surrounded and invaded the sponge implant. It was obvious that the thoroughness of the dissection of the capsule from the specimen could markedly affect the results of any quantitative mechanical tensile tests. Unfortunately, the fibrous capsule could not be dissected free in a uniform manner for each specimen. In addition, the tensile strength of the sponge itself could not be distinguished from that of

fibrous tissue that had grown into the interstices of the sponge. Therefore, no accurate measure of the tensile strength of the sponge alone could be made after fibrous ingrowth had occurred. For these reasons this approach to obtain in vivo tensile strengths of Ivalon was abandoned.

Implantation in Millipore chamber

Two Ivalon-Millipore chambers were successfully implanted intraperitoneally in each of 7 dogs, with no immediate postoperative complications. One animal died from unrelated bronchopneumonia 25 days after Ivalon-Millipore implantation. At autopsy, the chambers were removed after surrounding omentum and adhesions had been dissected away. Although the Millipore chamber showed a few fine linear cracks, the nylon backing remained intact. The chamber contained a small amount of serosanguineous fluid, but on gross and histologic examination the Ivalon sponge had no fibrous invasion. On tensile testing, the 25-day-old specimens showed no significant difference from the control Ivalon specimens.

Two dogs were sacrificed according to protocol at 6 months. At autopsy, dense adhesions from omentum and adjacent fibrous tissue produced infolding and crumpling of the chambers (fig. 2). Careful dissection showed fibrous tissue intimately adherent to the Ivalon implant through cracks in the Millipore at the base of infolding areas. Between the grooves, the fibrous capsule could be stripped free from the flatter surface of the nylon-backed Millipore. Because of the

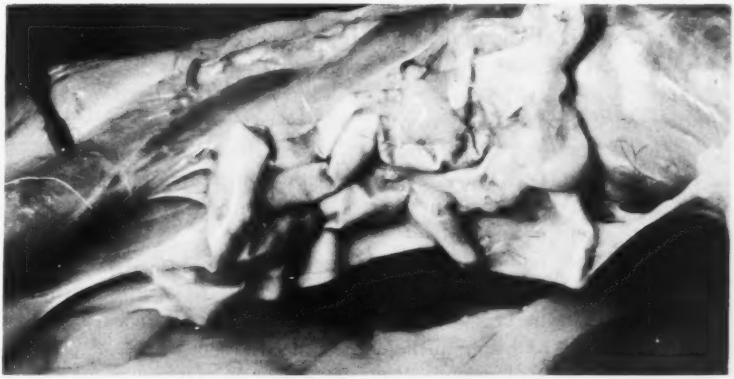

Figure 2. Photograph at autopsy 6 months following intraperitoneal implantation of Millipore-Ivalon test chamber. Note wrinkling and infolding.

fibrous infiltration none of the other Ivalon specimens were satisfactory for tensile testing. It appeared that contraction of the surrounding fibrous tissue resulted in wrinkling of the chamber, with secondary cracking and then fibrous invasion of the sponge.

To avoid cracking of the Millipore, we had planned to fasten the edges of the chamber to a rigid plastic ring of suitable shape and dimensions. We did not pursue this approach, however, because of mounting evidence from other aspects of our studies that Ivalon had limited value as a surgical prosthesis.

In Vitro Studies

Untreated specimens of graded ratios of compression

The stress-strain curves of all the Ivalon strips tested were similar in configuration (fig. 3). Nearly all the control strips could be elongated 175 to 200 percent before rupture of the specimen occurred: that is, a specimen initially 2 inches long had reached a length of 5½ to 6 inches at the point of rupture. Until a 50 percent elongation of the original length is reached, the curve is linear, with constant shape, indicating that in this range the sponge sample obeyed Hooke's law and acted like a truly elastic material. Beyond the 50-percent elongation, the material exhibited progressively less elasticity up to the point of rupture. At rupture the wave falls rapidly to zero load.

Since Ivalon retains its compressed shape after molding, heating, and cooling, it is obvious that adherent forces are acting in place parallel to the direction of compression. These adherent forces are, however, not adding additional strength to the sponge, which is compressed in one dimension and stressed perpendicular to that dimension. This fact was evident when the compressed pieces were tested and compared to uncompressed strips. The tensile strength of sponge compressed 2:1 was nearly double that of uncompressed sponge; the sponge compressed 4:1 was about twice as strong as that compressed 2 :1. Thus the tensile strength of a given compression of sponge was about equal to the tensile strength of uncompressed sponge multiplied by the compression ratio.

It might seem that Ivalon of the finer grade would have a somewhat higher tensile strength than the commercial-grade sponge; this did not prove to be the case. For comparable compression ratios, the 2 grades of sponge had nearly the same tensile strength.

The finer grade of sponge, however, was somewhat more elastic than the coarse grade, and a given load on strips of the same compression ratio resulted in somewhat more elongation for the fine grade than

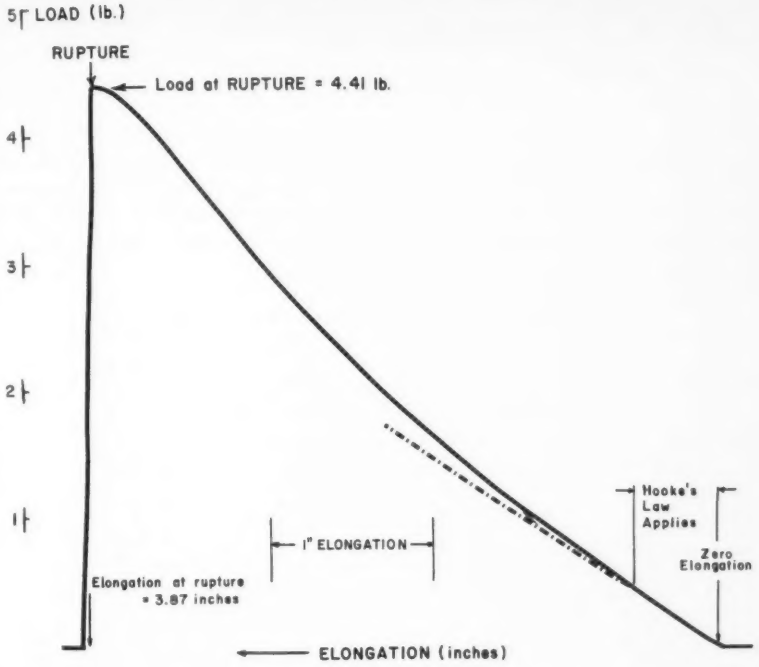

Figure 3. Representative load elongation (stress-strain) curve for Ivalon test specimen.

for the coarse grade. Since tensile strength is a function of cross-sectional area of any given test piece (tensile strength equals load divided by area) for the same compression ratio and sponge grade, both thicknesses of Ivalon have the same tensile strength. A specimen 2 mm thick—with twice the cross-sectional area of a specimen 1 mm thick—required twice the load to cause rupture.

Incubated specimens

All incubated Ivalon specimens as well as the untreated control strips were tested on the Instron apparatus. The average load at rupture for each set of strips was determined, as well as the standard deviation of the mean (table 1). Standard deviations were in all cases corrected for the smallness of the samples.[2] With these data from incubated and control specimens, a test was made of the validity of the hypothesis that no significant difference existed between the average load at

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rupture for the control specimens and the average load at rupture for a given set of incubated specimens. The calculations involved estimation of the standard error of the difference between 2 observed means, again corrected for small samples,[2] and estimation of the probability that the difference between the controls and the incubated specimens could have arisen by chance sampling. For this latter estimation, the "students' *t*" distribution[3] was used. In accordance with general usage, a difference between controls and incubated material is not considered significant unless the probability that the difference arose by chance sampling is less than 5 percent.

Table 1. ***Ivalon in vitro tensile strength tests***

Incubation fluid	*Incubation time*	*Average load at break for 4 specimens (lb.)*
Normal saline	6 wk	5. 34 *
	3 mo	5. 36 *
	6 mo	4. 44
	9 mo	4. 14
	1 yr	4. 03
Normal saline plus penicillin and streptomycin	6 wk	4. 73 *
	3 mo	4. 48
	6 mo	3. 59
	9 mo	4. 26
	1 yr	4. 11
Human plasma plus penicillin and streptomycin	6 wk	4. 52
	3 mo	4. 44
	6 mo	4. 00
	9 mo	3. 72
	1 yr	–
Control specimens (5)		
Average load at rupture (lb)	5. 03	
Standard deviation of mean (lb)	0. 452	

* Difference from controls not significant. (All others had significant loss of tensile strength.)

The results of these measurements and calculations indicate that in saline alone, no significant decrease in tensile strength relative to the controls occurs until after 6 months of incubation. In saline plus antibiotics, a significant decrease in strength is noted after 3 months' exposure. In plasma plus antibiotics, the decline in strength is significant after 6 weeks' incubation.

Figure 4 is a plot of the average load at rupture of the Ivalon for each of the 3 incubation fluids versus time of incubation. The data point for plasma incubated for 1 year has been discarded because of an error during preparation of the incubation flask. If the curve for

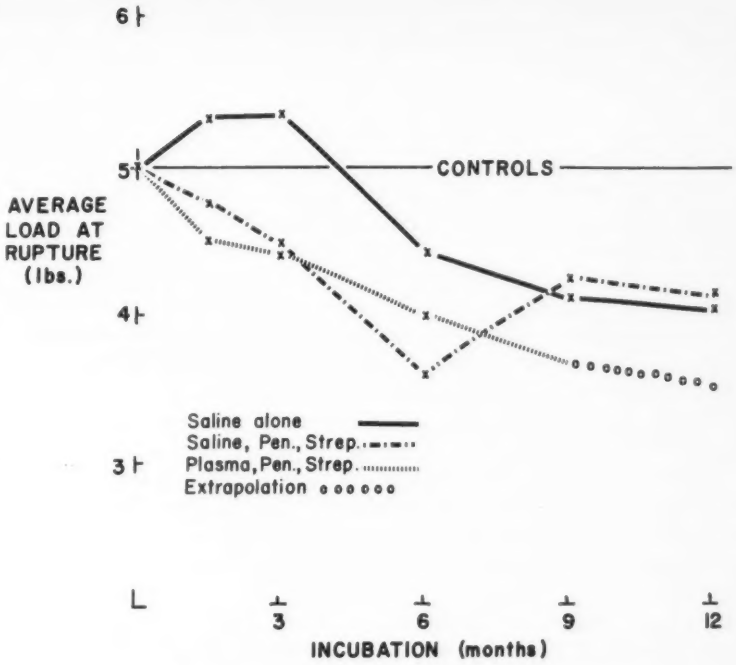

Figure 4. Results of incubation upon tensile strength of Ivalon specimens.

plasma incubation is extrapolated from 9 months to 1 year, however, the average load at rupture for the samples of this incubation would be about 3.5 pounds, a decline in tensile strength relative to the controls of about 30 percent in 1 year. Even after 9 months in plasma, Ivalon showed a decline in tensile strength of about 26 percent. For both the saline and saline plus antibiotics series, the decline in tensile strength after 1 year is about 19 percent.

DISCUSSION

The tensile strength of in vitro specimens of Ivalon increased in a linear direction as compression of the sponge increased; that is, a 2:1 compression had twice the strength of an uncompressed sponge, and a 4:1 compression had 4 times the strength of an uncompressed sponge. This effect is understandable, since the compression is in one direction and the stress is applied in a plane perpendicular to that of the compression. Unfortunately, this increase in tensile strength

is achieved at the expense of the porosity of the sponge. Porosity is desirable for fibrovascular permeation of the sponge and for incorporation of the prosthesis with adjacent tissues. As porosity decreases, the degree of fibrovascular infiltration decreases. We have already discussed [1] the disadvantages of fibrous encapsulation, lack of fibrovascular infiltration, poor tolerance in the presence of infection, and a carcinogenic potential—features that characterize a highly compressed sponge, which behaves in the body like an impermeable film.

Tensile strength tests show that Ivalon acts like a truly elastic material up to elongations of about 50 percent. Elasticity is a desirable feature in an Ivalon graft used to replace segments of large arteries. Unfortunately, as a result of fibrous infiltration, elasticity is lost along with pliability following implantation in the body for a sufficient period of time.

Specimens incubated in various solutions of human plasma and saline showed definite loss in tensile strength. Those incubated in saline alone showed significant loss of tensile strength relative to the controls only after 6 months; in saline with antibiotics this was noted after 3 months; and in human plasma with antibiotics, it was noted after 6 weeks. At 1 year, in saline with and without antibiotics, there was a 20-percent loss in the tensile strength of the sponge samples, and in plasma, a 30-percent loss. In vitro tests are not as indicative as in vivo implantation; but one may speculate that at least this much tensile strength would be lost in the body, where the sponge implant would be exposed to greater chemical and enzymatic activity rather than to a more or less static solution.

Ivalon specimens implanted in the body were unsatisfactory for tensile studies because of the uncontrollable fibrous infiltration and encapsulation. Thus it was impossible to measure the effects of in vivo implantation—dissociated from those of fibrous tissue infiltration—upon the tensile strength of the sponge. An attempt to encase the sponge specimen in a chamber of Millipore paper, allowing free diffusion of tissue fluids but preventing fibrous infiltration, was also unsuccessful for reasons described. Because of the other evidence from incubation tensile studies with animal implants, further attempts to expose Ivalon to in vivo implantation to obtain a quantitative measure of its loss of tensile strength were discontinued.

There seems to be no question that Ivalon loses tensile strength following implantation for a sufficient period of time in the body. The sponge appears to fragment and dissolve, and this can be best observed when it is implanted in a thin uncompressed form. Reliance upon fibrous infiltration to take over any function of strength is not

satisfactory. Scar tissue invariably stretches and gives way under continued stress. We have observed hernias recur through scar when a prosthesis of nylon disintegrated, and we have seen Ivalon vessel grafts dilate when exposed to aortic pressure despite considerable fibrous infiltration and encapsulation. It would appear that an ideal prosthesis must maintain its integrity and tensile strength and not depend upon fibrous tissue to take over this function.

Based upon our total experience, we feel that Ivalon in its present form loses a large degree of elasticity and tensile strength in the body and is not a satisfactory prosthesis for areas of stress or pressure, such as bridging tissue defects, reinforcing hernias, and supporting the pulsating load of systemic arterial pressure. Also, as discussed in part I of this study,[1] it is unsatisfactory as a space-filler or subcutaneous mold because of its shrinkage and hardening. In addition, it is poorly tolerated in the presence of infection. Finally, it is potentially carcinogenic; if highly compressed to increase its tensile strength, this potential would appear to be greater. For these reasons we believe that Ivalon is inferior to certain other plastics in current use.

We have considered the possibility of increasing the tensile strength of Ivalon, while maintaining its desirable porosity, by incorporating a plastic mesh of Dacron [4] between 2 sheets of Ivalon. We have used knitted Dacron (Mersilene) mesh as a sandwich between two 1-mm thick leaves of Ivalon that had been subjected to 4:1 compression. This sandwich maintained most of the desirable in vitro qualities of Ivalon, but the interposed mesh prevented good bonding between the 2 compressed Ivalon slices. Theoretically this could be overcome by using a mesh of larger porosity. Similar modifications of Ivalon have recently been published.[5, 6] In general, despite the addition of this reinforcing skeleton, we prefer at this time to use Teflon or Dacron when a prosthesis is to function under conditions of pressure and stress.

SUMMARY

Various approaches to study the tensile strength of Ivalon following in vivo implantation are described. Under simulated in vivo conditions Ivalon definitely loses tensile strength. Following incubation at body temperature for 1 year Ivalon suffers a 30 percent loss of tensile strength in plasma and a 20 percent loss in saline. It is difficult to evaluate tensile strength of the sponge samples following implantation in the body because the effects cannot be dissociated from those of the uncontrollable fibrous infiltration. In the body the loss in tensile strength, although difficult to quantitate, is more pronounced than with incubated specimens.

Ivalon subjected to controlled ratios of compression shows an increase in tensile strength directly proportional to the degree of compression and thickness of the specimen. As the degree of compression increases, however, the degree of fibrous encapsulation increases and fibrovascular infiltration through the sponge decreases. Highly compressed sponge becomes hard and wrinkled and acquires an increased carcinogenic potential. The tensile testing apparatus shows Ivalon to be truly elastic at low levels of stress, but elasticity is lost following implantation in the animal body.

Our studies add support to those in which dilatation and rupture of Ivalon aortic grafts have been demonstrated. Ivalon loses a large part of its tensile strength after implantation in the body. At low ratios of compression it appears to fragment and dissolve. Fibrous tissue that infiltrates and surrounds the prosthesis cannot be expected to hold up under conditions of continued stress and pressure. Our present impression is that Ivalon itself is unsatisfactory as a prosthesis to support systemic blood pressure or to bridge or reinforce hernias and tissue defects.

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THE NONCONFORMIST

> The clavicle, as a bone, is a nonconformist. It is the first to ossify in the embryo, and it continues throughout life to enjoy a remarkable reputation for its ability to form bone and heal.—CHARLES S. NEER, II: Nonunion of the Clavicle. *The Journal of the American Medical Association*, March 5, 1960.

Studies in Human Isolation II. Hallucinations and Other Cognitive Findings

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THE HALLUCINATORY AND OTHER COGNITIVE EFFECTS to be described in this portion of our study may be considered in contradistinction to the perceptual findings presented in part I. An attempt will be made to answer the question whether these two kinds of effects are directly related—are simply different kinds of evidence of a general deterioration of ego functioning in a situation where reality testing is severely limited.

Almost every report of sensory deprivation experiments describes visual imagery often referred to as "hallucinations." It is implied that the phenomenon is uniquely related in some unexplained way to the sensory deprivation situation, although in general the published reports do not attempt to probe this relationship or analyze the dynamics and formal characteristics of the imagery. We believe that a careful inspection and analysis of the formal characteristics and the conditions under which they occur will make it possible to relate the phenomenon to other kinds of normal visual experience. Because of connotations of abnormality and psychosis, the term "hallucination" would seem to be inappropriate. The following definition from a psychologic dictionary [29] is illustrative:

Hallucination: a false perception which has a compulsive sense of the

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reality of objects although relevant and adequate stimuli for such perceiving are lacking; the acceptance of sense imagination as real. It is an abnormal phenomenon, though occasionally experienced by normal persons.

The term "imagery" can encompass a range of phenomena, with those of hallucinatory intensity and conviction at one extreme and without any connotation of mental illness. Results of the present research indicate that the reported imagery of sensory deprivation is a type of hypnagogic imagery induced by the experimental conditions and occurring more frequently in subjects who have richer visual imagery under normal everyday conditions.

Bexton, Heron and Scott [1] were the first to describe hallucinations, which were found "quite similar to what have been described for mescal intoxication, and to what Grey Walter has . . . produced by exposure to flickering light." All their 14 subjects experienced simple visual phenomena such as "dots of light, lines, or simple geometric patterns"; 11 reported seeing "wallpaper patterns" as well as isolated figures or objects; and 3 described integrated scenes such as "prehistoric animals walking about in a jungle." The phenomenon was very vivid to the point of interfering with sleep, was not completely under conscious control, and disappeared when the subject was doing a complex task. In a more detailed description Doane [3] reports similar imagery for 9 of 13 subjects. Only 4 reported seeing discrete objects such as animals, a ship, or printed words, and only 3 described complex images such as landscapes or groups of people. Subjects usually reported movement in their imagery, and those who experienced complex images usually first reported the simpler forms.[3] "Once having started, the hallucinatory activity usually continued during a large part of the subjects' waking hours for the remaining period of isolation. Some subjects reported that the visual activity became more intense as time progressed, while others found that it waxed and waned." On the basis of a few trials with darkness followed by diffuse light (2 subjects), diffuse light followed by darkness (5 subjects), and diffuse light in the absence of other impediments (4 subjects), Doane [3] seems to have felt that prolonged interference with normal vision by translucent goggles was the key factor in the production of imagery.

With a similar situation, Goldberger and Holt [7] found that 9 of 14 subjects reported the spontaneous occurrence of visual imagery that often was quite vivid and in a number of cases seemed to be "meaningless" in content. They comment that the images generally occurred in a drowsy, sleeplike state, and conclude that "perceptual isolation primarily tends to increase the vividness (intensity) and structure of imagery" and that monotony or homogeneity of stimulus input is

the crucial factor in its production. We may note here that the conditions of isolation are fairly similar to those of the McGill studies,[1-4] and as far as we can determine from the reports, the hallucinatory-like activity is also similar.

Vernon, McGill and Schiffman [13] report 2 studies in which only the simplest types of visual imagery were noted by subjects, i.e., flashes of light, flickering lights, dim glowing lights, geometric shapes, and forms. The conditions of isolation were significantly different; reduction of stimulation rather than nonpatterning of stimuli was the aim by use of a blacked-out, soundproof chamber. In the first study, where blackout was not completely successful, 6 of the 9 subjects reported simple hallucinations. With complete absence of visual input only 1 of 11 subjects reported the phenomenon, and the authors cast some doubt on this report. The importance here lies in the differences in isolation conditions: reduction rather than nonpatterning of stimulation and free motility rather than confinement to a bed. The authors [13] conclude that visual stimulation in the absence of patterned vision "produces . . . the greatest number and the greatest variety of hallucinations."

Kandel, Myers and Murphy [30] report an experiment in which subjects lay on a bed in a semilightproof room wearing opaque goggles. After 10 minutes the subject was asked to describe his visual sensations. One minute later, if he had responded by talking, he was told he was doing fine; but if he had remained silent, he was prodded. Most subjects reported imagery ranging from simple to very complex. The conclusions of these investigators emphasize the importance of instructions and "other implicit or explicit sets associated with the experimental conditions." This experiment shows that with strong suggestion, motivation, and reward, subjects will report many visual images; it does not seem to be essentially relevant to isolation.

Pinard [31] has been conducting experiments in "spontaneous imagery" since 1948. In his situation subjects are instructed to sit down and make themselves as comfortable as possible. "They are asked to close their eyes and to look with their 'mind's eye' . . . as if looking through a point in the middle of their forehead, and to concentrate on what they 'see' . . . in no way to conjure up anything or attempt to hold what they see." Pinard [31] specifically compares the productions of his subjects to the reports of the McGill group [1-4] but states that spontaneous images may go much further, are more "vivid, real, and detailed" and more easily recalled than other types of imagery. Here is another example of the importance of motivation and set in the production of visual imagery, in this case without any emphasis on sensory deprivation.

"HALLUCINATORY" FINDINGS

Before describing these findings, it might be well to raise a methodologic problem. It is sometimes difficult to ascertain from subjects' reports the exact nature and meaning of their experiences. There are 2 extreme types of reports. One kind of subject spontaneously reports complex imagery during the course of the experiment, giving a detailed description as it occurs. He is apt to elaborate on this description in the postexperimental interview and is obviously impressed by the phenomenon. There seems to be no question that subjectively he has had an experience. The other kind of subject may say very little during the experiment, mentioning nothing about imagery. Only when questioned after the session does he describe images; they may seem unimportant or insignificant to him. They were not elaborate, perhaps only flashes of light or color. Obviously, the subjective experience here is different. Did such a subject really experience imagery or is he unconsciously trying to please the experimenter? Is he possibly attributing a visual accompaniment to some other sensation or to a thought? We have eliminated such cases from the following discussion and have considered only those who spontaneously reported what seem to have been definite subjective experiences.

Visual imagery was reported by almost half the subjects in the 2 main experimental groups—4 of the 10 diffuse light subjects and 4 to 10 blackout subjects. Thus, there is no difference between the diffuse light and blackout conditions in the production of visual imagery in this experiment. For illustrative purposes in the following discussion, references are made to 6 other subjects not in the main experimental groups but run under comparable conditions. If these are included, a total of 7 out of 16 diffuse light and 4 out of 10 blackout subjects experienced imagery.

Four subjects were run under both of the 2 experimental conditions. Of these, 2 reported definite imagery under both conditions; 1 had minimal or no imagery under either condition; and 1 described a single definite image only on his second session, blackout. These results are in line with other findings and are suggestive, but the number of subjects was too small for statistical significance.

The content of the imagery was frequently baffling to the subjects. Although usually rather pleasant, it was surprising and sometimes frightening. The imagery seemed largely unrelated to past experience or to the current situation of the subjects. There were, however, varying degrees of irrelevance. The whole image might seem to be irrelevant, even absurd:

Subject 21. "The herd of elephants. Oh, that was pretty, that came very spontaneously. It was just sort of elephants in black, with pink and blue and purple . . . they were moving. The picture was moving as if it were a close-up, sort of a backdrop . . . the elephants were gray . . . the background was pink . . . they weren't real elephants, because they were more like cutouts."*

The reason for this image cannot easily be determined. The subject was certainly surprised and impressed by it. The image may not, however, be so totally removed from the past experience of the subject.

Subject 28. "Yeah, they were sort of grayish black socks. It was a white shelf about that big. About 3 feet wide and 2 feet deep and just covered with a mountain of socks. The significance of that is that my clothes are kept in that type of arrangement . . . that might possibly be the connection."

Nothing was strange about the image. The irrelevance stemmed from his not knowing why he saw it when he did. On the other hand, some images do not seem irrelevant. One subject saw a turkey in front of him for a second. Just before seeing the turkey he had thought of food and about his being hungry.

Subject 23. "I was getting hungry. I . . . I saw sliced turkey on a plate. It was very, very brief."

Not only does the subject matter and structure of a particular image usually seem foreign or irrelevant, but also the succession from one image to another is without apparent meaning or order. In only 2 subjects could any order be surmised: The majority of 1 subject's images were in an oriental setting, for no apparent reason, and many of the other's images seemed to be closely related to current emotional problems.

Another characteristic of the images is the apparent lack of control that subjects have over them. Most subjects say they tried but were unable to produce, prolong, or stop imagery. (One subject reported that he could make them appear if he relaxed, but that he could not control the content. Others said they could make an image disappear by distracting themselves.) In many cases, control was not even possible. The images were so fleeting that they would be gone before the subject could react to control them.

Usually, the images were colored. Several subjects commented on the vividness of the hues and the beauty of the colors. One subject's only image was a green pasture.

Subject 30. "I did see one thing . . . uh . . . a very bright green pasture or lawn. I'm not quite sure which, and that was fleeting, too. Just a broad open expanse. Just green grass."

*All quotations taken from subjects' reports after the experiment, unless otherwise indicated.

Duration of the imagery was usually brief. Occasionally—and this was especially true for those subjects who had many images—they lasted for a longer period. One subject's images apparently were quite involved, each lasting for several minutes. Usually, however, they lasted no longer than a few seconds. Subjects compared them to a succession of lantern slides of brief duration. Some subjects saw no movement in the images; others saw a great deal of movement. In spite of brief duration, great detail was usually reported.

We may summarize by saying that the general characteristics of the reported visual imagery in this experiment are: (1) Subject matter and form are seemingly irrelevant to the subjects' past experience and current situation. (2) Images cannot be controlled as to content, appearance, or duration. (3) Vivid colors and quite striking detail appear. (4) Duration is very short, with apparently unrelated succession of images.

The similarity of these phenomena to hypnagogic and hypnopompic imagery is striking and suggestive. Goldberger and Holt[7] have also commented on this similarity. In an early review of the subject, Leaning[32] cites many reports reminiscent of those of our subjects. He emphasizes that hypnagogic imagery is a normal event (estimated 33 percent incidence), involving "superdistinctness," endless variety, vivid color, unexpected content, and autonomous occurrence. McKellar,[33, 34] who studied hypnagogic experience in 182 college students, emphasizes the following as typical characteristics: (1) autonomy—inability to control occurrence or content; (2) irrelevance—to thoughts of the subject going on at the time; (3) originality—"highly creative and unreproductive"; (4) color—"frequently coloured in unnaturally vivid hues"; and (5) duration—usually extremely brief.

Thus, in all these formal characteristics reports of our subjects coincide with the descriptions of Leaning[32] and McKellar.[33, 34] Both authors found visual and auditory imagery to be most common—also true of our subjects. Furthermore, McKellar mentions kinesthetic, thermal, tactile, and olfactory images. Our subjects have likewise reported imaginary sensations in other modalities:

Olfactory image. Subject 35. "I think I woke up from a sleep and found that . . . a great odor around me. It was very powerful odor . . . like garbage or something. It went away . . . it went away about 3 times and finally went away altogether."

Purely auditory image. Subject 31. "Yuh, I heard my wife once say 'honey' and I also heard what I thought was like a muffled conversation. I couldn't begin to identify any voice or even any words . . . it really sounded real."

Auditory image accompanying visual imagery. Subject 19. "One of the more peculiar images that I saw with music was—I was looking up at a wood shelf;

not very big, and watching the shelf, and listening to the music, and then the shelf started to wave in rhythm to the music in a very plastic fashion."

Subject 35 (during experiment). "Crates of all kinds. They start with the large wooden crates at the bottom and they sort of pyramid up. They get up to about 6 levels of boxes . . . another 6 levels . . . it gets higher and higher . . . 5 miles, 10 miles, and finally 14 miles . . . 14 miles high. The highest pile of boxes in the world. Watch out—the pile is collapsing . . ." Subject later reported that he could hear the crash reverberating and had been frightened.

Kinesthetic imagery. Sensations of falling, of floating in air (with or without the bed), and of tipping were reported.

However, simple visual imagery was by far the most common. The following examples are illustrative:

Subject 26. "They were just black and white, but very white faces, theatrical There was a Chinese lady with a white face and the black hair with pins in it and, uh, she was . . . they had these sliding kind of doors like they have in Japan . . . She was motioning someone within, and so, I tried to move forward and I got a better look at the lady; but I tried to look at who, what, she was motioning to. When I tried to look into the room, the whole thing went, and that was it."

Subject 45 (during experiment). "Image of a crocodile head with its lower jaw flapping up and down . . . he's got kind of a smile on his face and his tongue is sticking out . . . Now there's a lot of rows of little tiny teeth. The teeth are so small and fine they're almost like a hairbrush. Now it's like 2 hairbrushes with teeth made out of porcupine quills . . . Now the teeth have fallen out. The left-hand hairbrush has turned into one of these light-switch covers . . ."

Subject 19. "Abstract images of just, you know what a paneling might look like, of the French paneling with one box set inside of another in depth . . . a whole long line of these things at angles to each other . . . sort of a nice brownish [color] . . . more distinct than I'd seen them before . . . probably greater detail than it has been possible to see it."

DISCUSSION OF "HALLUCINATORY" FINDINGS

In everyday life hypnagogic and hypnopompic imagery occurs in transitional states between sleeping and waking. Many factors in the sensory deprivation experiment are conducive to such a state: Almost all subjects sleep for awhile, especially at the beginning of the experiment. They are lying on a bed, movement is restricted, and what little visual and auditory input exists is monotonous. These conditions would seem to promote sleep and resemble what happens when one goes to bed at night. Other aspects of the situation, however, promote wakefulness: the earphones and goggles may be uncomfortable, subject is constrained to lie on his back or side, perhaps not his normal sleeping position, and anxiety may lead to a general defensive alertness. Also, some subjects have reported that they tried to stay awake because wakefulness was thought to be essential to the experiment. If the forces promoting and preventing sleep come into

balance, the subject may remain in an in-between state for long periods.

Introspective reports also indicate the occurrence of a transitional state between sleeping and waking. Of the 8 subjects reporting definite imagery, 6 stated that they could not tell when they were asleep or awake, and 5 thought they were in some in-between state: only 1 subject reported that he could clearly differentiate.

Most subjects who reported vivid imagery indicated that the images came in groups rather than singly. The average time of onset was at about the 5-hour mark. One subject, typical in this respect, reported nothing for the first 6 hours, over 20 images during the seventh hour, and nothing during the eighth hour. If these images are hypnagogic, then grouping is to be expected, as the forces promoting and preventing sleep come into balance.

Comparison between sensory deprivation imagery and psychotic hallucinations is not easy. Certain subjects seemed to have interacted with their imagery in a way suggesting the breakdown of reality testing. In one case a presumably healthy subject tried to eat an "imaged" salad. McKellar [34] has also reported this kind of interaction; we have, however, no right to make any assumptions about the psychologic health of his subjects. Another of our subjects became quite frightened by his imagery. He had been diagnosed as borderline psychotic and in poor control. Obviously the sensory deprivation experiment restricts opportunities for reality testing. Our less healthy subjects seem to have been more inclined to interact with their imagery perhaps because their grip on reality was initially more tenuous. But there is no clear relationship between ego integrity and the production of visual imagery. The subject who finds the situation unthreatening and is able to regress without fear may be just the one to produce a quantity of imagery. An overanxious subject may repress or be afraid to report the occurrence of imagery.

Perhaps a much more important variable in the production of imagery is the nature and extent of the subject's normal imaging experience as in dreams, daydreams, and hypnagogic states. Unfortunately our interest in this variable was not aroused until late in the research and complete data are available for only 15 subjects. With these 15, however, there is statistically significant correlation between a history of hypnagogic imagery and reports of imagery in the sensory deprivation experiment ($P = .05$, Fisher's exact probability test).

Bexton, Heron and Scott [1] described 4 arbitrary levels of complexity for visual imagery and reported that more complex "hallu-

cinations" were usually preceded by simpler ones. Using the same categories, Kandel, Myers and Murphy [30] reported a definite developmental trend in complexity. We found no such developmental trends with our subjects. Many described very complex images without any previous simpler ones. One subject described both simple and complex images alternately.

In conclusion, the production of imagery in sensory deprivation seems to be related to a homogeneous visual field regardless of its intensity. Restricted motility is probably important but not demonstrated in the present research. The imagery closely resembles hypnagogic (and hypnopompic) imagery in its formal characteristics, mode of appearance, and content. Subjects with a history of hypnagogic imagery will be more likely to report imagery in sensory deprivation.

OTHER COGNITIVE FINDINGS

In this research, range and variety of response have been broad, probably related to differences in personality and preferred modes of defense. Some subjects have slept a good part of the time; others have kept themselves busy reciting poetry, doing mental arithmetic, reviewing stories, or moving around. Many have slipped into hypnagogic states for long periods of time, and in the pilot study preceding this research, 1 became overtly paranoid, accusing the experimenters of trying to drive him insane in order to keep him in the mental hospital as a patient. Those who were able to relax and give themselves to the situation found it pleasant and were willing to return for another session if asked. Those who construed the experiment as threatening fought against it and found it unpleasant.

In addition to the perceptual changes and hallucinatory-like imagery already noted, most experimental subjects reported changes in cognitive functioning and changes in feelings about themselves, about others, and about the environment; none of the controls gave such reports. In general, these reports are not as striking as those recorded by some of the other sensory deprivation experimenters [4, 5, 8, 17]. This difference may be related to: (1) differences in experimental stress, (2) the relatively short extent of our sessions, 8 hours, and (3) the particular interests of different experimenters.

There seems to be little difference between the effects of blackout and diffuse light in the production of these kinds of phenomena. The Mann-Whitney U test for subjects' ranked scores on the production of such phenomena gives a value of $U=64$. (The critical value of U for a 2-tailed test, $\alpha=.10$, is $U=27$.) Table 6 summarizes the reports of all the experimental subjects.

Table 6. ***Cognitive effects reported in postexperimental interview***

Subject	*Visual imagery*	*Auditory imagery*	*Body illusions*	*Difficulty in concentrating*	*Inability to talk*	*Anxiety perceived by subject*	*Loss of time sense*	*Fears or fantasies*
				DIFFUSE LIGHT GROUP				
12	0	0	+	+	+	+	+	?
19	+	+	+	+	+	0	+	+
14	+	+	0	+	+	+	+	0
13	?	0	+	+	+	+	0	+
21	+	+	+	+	+	+	0	+
23	+	+	0	+	+	0	+	0
27	?	+	+	+	0	+	+	+
36	?	0	0	+	+	+	0	0
43	?	0	0	+	0	+	+	0
48	0	?	0	+	+	+	+	?
				BLACKOUT GROUP				
24	+	+	+	0	+	0	0	0
26	+	0	+	+	0	0	+	0
28	+	+	0	+	0	0	+	0
30	+	0	+	+	+	+	0	+
31	?	+	+	+	0	+	+	0
33	0	0	0	0	+	0	+	+
37	?	0	+	+	+	+	+	0
40	0	0	+	+	+	+	+	0
50	?	0	?	+	+	0	+	0
47	0	0	+	+	+	+	+	0

+ effect reported
0 no effect reported
? possible but questionable effect

Almost every experimental subject reported difficulty in thinking coherently and in concentrating. Some who tried counting to pass the time were unable to count consecutively beyond 20 or 30 digits.

Three quarters of the subjects found it difficult to talk in spite of explicit instructions to report, commenting: "It was too much effort," "It wasn't worth the trouble," "I feared it would break the spell," or "Talking made the illusion disappear."

Of the 20 experimental subjects, 12 reported some kind of body illusion or disturbance in the body image, e.g., arms dissociated from body, floating in the air, body rigid and unable to move. Although these reports were largely of transitory phenomena and many were not striking, several were interesting:

Subject 24. "The only other thing I had during the whole thing was where the arms were directed . . . I could not . . . was not sure which way the arms were directed in those tubes. You don't know which way your arm is pointing."

Subject 19. "I got the sensation of . . . not feeling my arms . . . instead of lying beside me, I sort of felt they were lying on top . . . and so I tried to move them without, uh, without moving them physically, and that was more or less successful."

Subject 13. "Toward the end, I felt bigger in the legs and . . . like I didn't have any arms."

A number of the subjects reported fears of an unreal or paranoid nature. Several thought that another person came into the room during the experiment; one (in the pilot study) expected a steel casket to drop from the ceiling and enclose him; and another (also in the pilot study) imagined an infernal machine bearing down on him to destroy him.

Fear of abandonment was common and usually accompanied by the fantasy that the building might burn down. With longer periods of deprivation and increasing anxiety, it is easy to conceive of such fears becoming greatly magnified and even overwhelming.

Most subjects lost track of the passage of time early in the experiment, particularly after their first nap. When questioned, they underestimated the total elapsed time by as much as 4 hours. Only 1 subject overestimated the total elapsed time. The defensive nature of this underestimation is evident by the comments of 4 subjects that they had deliberately tried to underestimate in order not to become panicked by thinking the end had arrived earlier than it actually did.

DISCUSSION OF "OTHER" COGNITIVE FINDINGS

Although it is difficult to make firm generalizations about these findings, a number of suggestive hypotheses emerge from the data. Subjects tend to slip into a dreamlike transitional state between sleeping and waking that makes coherent thinking difficult; thought cannot be anchored in reality and the free flow of fantasy is promoted. We may note the similarity to the analytic situation, which is designed to provide a monotonous sensory environment precisely in order to encourage the free flow of fantasy. There is less motivation to speak in the absence of reply, and fantasy about the experimenters is un-

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checked. It is, therefore, not surprising that paranoid fears arise. The occasional extent of such fears, however, *is* surprising and suggests rapid breakdown of the perception of social reality, in terms of the normal subject-experimenter relationship. The body image tends to change because the subject is unable to touch or see himself and because motion is restricted.

The majority of the above effects, however, resemble reports from normal subjects under more normal conditions: transitory changes in the body image, passing fears, and unreal fantasies. Without data on the occurrence of such phenomena in everyday life, it is impossible to evaluate the significance of the subjects' reports. Nevertheless, it is reasonable to assume that sensory deprivation enhances and promotes such phenomena and that with more stressful conditions than those of the present research, more striking effects might be anticipated.

COMPARISON OF COGNITIVE AND PERCEPTUAL EFFECTS

To study the problem of whether cognitive and perceptual effects are related, subjects were roughly rated and rank-ordered for their reports (table 6) of visual and other sensory illusions, body illusions, difficulty in concentrating, inability to talk, perceived anxiety, loss of time sense, and fears and fantasies. These rankings were compared with rankings on the test for perception of simple forms. The Spearman rank correlation coefficient was +.27, which is not significant. (The critical value for .05 significance on a 1-tailed test would be .377.)

In this laboratory, over fifty 8-hour deprivation sessions have been run, and we have long been strongly impressed with the feeling that there was no relationship between the two kinds of effects. Some subjects with the greatest perceptual aberrations after the experiment reported no hallucinatory-like visual imagery or other cognitive effects. The reverse was also true.

It would appear, therefore, that the visual perceptual effects reported were directly related to particular kinds of prolonged visual stimulation, i.e., homogeneous, nonpatterned fields instead of normal patterned vision. On the other hand, cognitive effects are probably related to social isolation, inability to test reality, personality differences, and the total unstructured situation.

The sensory deprivation situation may be conceptualized as an unstructured behavioral projective test. The structure any subject imposes on the situation will most likely determine his fantasies, anxieties, speech-blockings, and other cognitive effects. Each subject, in accord with his own personality and needs, has an *Einstellung* or

set; he is prepared to perceive certain things in the situation and to make certain inferences from the minimal cues presented. What the subject brings with him to the situation may largely determine his subjective reactions.

The situation in itself is neither threatening nor unthreatening, pleasant nor unpleasant; but since the threshold of tolerance for ambiguity is low, the subject must define the situation somehow for himself. In the absence or ambiguity of external cues, regression and fantasy are encouraged; the subject must look within himself to define the situation.

We may well inquire why subjects participate if they perceive the experiment as threatening. For the most part money does not seem to be the prime incentive, although it does help to arouse interest. Some subjects apparently want to know more about themselves; or they may view the experiment as a test and want to know how they compare with other people. Motivation may be counterphobic: "I have to prove that I'm not afraid of this experiment—just because I am."

The subject who structures the situation as threatening or who enters with the counterphobic attitude has to fight the experiment; his defenses are up even before he begins, so to speak. On the other hand, the subject who considers the situation as nonthreatening or even potentially pleasant can relax and enjoy it; there is no need to defend. The first subject is fighting a straw man of his own creation and in so doing keeps feeding his own anxiety.

SIGNIFICANCE

Isolation as Such

Sensory and social isolation are inevitable conditions imposed on men in many military and industrial assignments: e.g., men in the Arctic, sentries at night, radar and sonar observers, long-haul truck drivers on straight, monotonous highways. This research demonstrates that conditions of prolonged monotonous visual and auditory stimulation combined with greatly restricted motility bring about changes in perception and cognition that would impair the operator's ability to perform his assigned task accurately.

Periodic interruptions would be desirable, therefore, to prevent the prolongation of such conditions. The use of sound stimulation to preclude auditory monotony suggests itself. Because of adaptation effects, the sound source should be turned on and off at irregular intervals. The presence of a second person to provide social stimulation for the operator might help to prevent perceptual disturbance. Social

interchange would seem to be more desirable than the mere presence of another person, and it might be most desirable for the second person to appear and reappear at intervals. If 2 persons are to be assigned to a monotonous task, it would be better if they alternated at short intervals than if both operated continuously.

Isolation under the name of "seclusion" has long been used in mental hospitals as a form of "treatment," although in recent years many hospitals have been making efforts to do away with the practice. The patient is locked in a small room, where vision is often limited to the bare walls and audition is limited by the heavy door and the location of the room far from the center of activity. Since such isolation tends to promote fantasy, regression, and bodily illusions in normal subjects, it would seem to be contraindicated for psychotic patients. Azima, [8–10] the only investigator who has described isolation experiments with neurotic and psychotic patients, reported marked disorganization in all 14 of his cases and the development of acute psychotic episodes in 2 neurotic patients. Sensory deprivation experiments support the growing feeling in modern psychiatry that seclusion is harmful to mental patients.

Isolation as "solitary confinement" is used as punishment in prisons. To the extent that isolation is not always felt as stressful, it loses any value as a disciplinary measure; to the extent that isolation is preferred or sought after, it would very upsetting to administrative routines in penology. In the present research, 5 of the 20 experimental subjects definitely described the sensory deprivation experience as pleasant, 7 described it as definitely unpleasant, and the views of the other 8 were indeterminate. Ten of these subjects were willing to return for another session, several offering to do so spontaneously. Thus, sensory deprivation is by no means uniformly stressful and may even be pleasant and gratifying to some individuals. In this regard Meltzer [35] has reported from his experience at Alcatraz:

"There were some inmates who were inclined to use solitary as a retreat and catalyst for a regressive experience of the mystical union type. This was the fellow who instead of being shoved into solitary, would dive in. . . . There was the occasional prisoner who would openly ask to be put in solitary."

Sensory deprivation experiments lend support to Meltzer's findings and point up the necessity of individual evaluation of prisoners' attitudes toward confinement rather than rigid use of a device that may defeat its own purposes.

Relationship to Schizophrenia

Loss of spatial and temporal orientation, feelings of depersonalization, paranoid manifestations, and changes in the body image have been

reported in this and other sensory deprivation studies.[1, 9, 18] All these phenomena duplicate or resemble common schizophrenic symptoms. Furthermore, both perceptual and cognitive disturbances replicate the picture that is produced by lysergic acid and that has often been designated a "model" schizophrenic psychosis. Sensory deprivation may be considered a situation in which sensory and social isolation are imposed on a subject, as compared with schizophrenia, in which such isolation is self imposed.

Despite these tantalizing suggestions, clinical impressions from the present experiment do not lend support to the alleged relationship between sensory deprivation and schizophrenia. It may be true that deprivation accentuates disturbances already present, as in the pilot study subject who became paranoid and frightened. Another subject, who had been diagnosed as borderline psychotic, became quite frightened by his visual imagery. By and large, however, body illusion, fears, and fantasies were transitory and resembled phenomena occurring under normal conditions. In the absence of normative data about the incidence of such feelings, it is impossible to draw any conclusions about the subjects' reports.

The most striking "hallucinations" reported in this experiment were visual, whereas schizophrenic hallucinations are mostly auditory, usually consisting of someone's talking to the patient. Such auditory imagery as was reported by our subjects was briefer, less complex, and less frequent than the visual imagery. Furthermore, as brought out in the discussion of "hallucinatory" findings, the visual images of this experiment can be considered to be hypnagogic phenomena.

In conclusion, the present study does not confirm any alleged relationship between sensory deprivation and schizophrenia nor does it indicate that an 8-hour period of deprivation brings on a schizophrenic-like state.

Dependence on Structured Environment

This experiment demonstrates the importance of a patterned environment for effective perceptual and cognitive functioning. It points up the fragility of the human organism and its tenuous hold on reality. The many supports of one's normal environment, such as orderly relationships and familiar objects and people, serve continuously to reaffirm and strengthen bodily, spatial, and social schemata that provide unbroken orientation as to who you are, where you are, and what you are. Because of their multiplicity, variety, and omnipresence, such supports are customarily ignored. It is only when they are removed, as in sensory deprivation, that their importance becomes

obvious. Thus, the experiment strikingly reveals how easily the human organism may be disoriented by simple interference with his customary relationship to his environment.

LIMITATIONS OF THIS RESEARCH

One serious limitation of this research was the inability to exert adequate control over subject's expectations and possible unconscious cooperation in the production of effects. Although we tried to obtain unseasoned subjects by eliminating applicants who were psychology majors or had participated in a great number of experiments, it would be naïve on our part to assume that the subjects knew nothing of the nature of the experiment. Expectations were discussed in the preliminary interview and often further information came to light during the experimental session. For some subjects the term "sensory deprivation" was anxiety provoking; for others it seemed to imply possible alteration of sensory mechanisms. It is likely that many subjects had read about similar experiments in newspapers or magazines; in fact, one found an article about Vernon's work[6,13] in *Life* magazine while waiting for his interview. During the session several subjects spontaneously associated the experiment with space travel and anticipated that "something weird would happen." The very fact that the same perceptual tests were repeated after the experimental session could have meant to the subject that the experimenters were looking for changes.

Nevertheless, we feel confident that the effects reported are real, although perhaps contaminated by the subjects' expectations and desire to please. The similarity of effects with different subjects and the regular occurrence of some effects with all experimental subjects are convincing. Moreover, expressed expectations did not coincide with phenomena reported in the experimental situation. Several subjects expressed disappointment at not experiencing the "hallucinations" they had anticipated. Others, who had been confident that nothing in particular would happen, recorded substantial perceptual changes.

The problem is not so easily disposed of. Perhaps the best way of attacking it is to devise tests that are not subject to unconscious influences because the subject cannot predict the experimenter's hypothesis about the task. The perceptual lag test described in part I of this study is such a one. Since most subjects do not even understand the true nature of the task—and certainly cannot predict the expected direction of change—it is virtually impossible for unconscious influences to contaminate the results.

Such a test procedure would be helpful in future sensory deprivation studies, to make results more precise and meaningful. There is no question that other tests of this nature can be developed to overcome the influences of subjects' expectations and unconscious cooperation.

SUMMARY

Thirty normal subjects were used in 8-hour experimental sessions involving (1) nonpatterned visual and auditory input combined with social isolation, (2) visual deprivation (blackout) combined with auditory nonpatterning and social isolation, and (3) social isolation alone. Perceptual and cognitive distortions and disorientations differentially induced by these conditions are described.

Perceptual and cognitive effects of sensory deprivation similar to those reported in the original studies at McGill University can be obtained with normal subjects in 8 hours or less. Although in this research the most striking perceptual effects were those indicated by subjects' reports and drawings of the way simple forms looked to them, more precise technics such as the perceptual lag test can quantitatively measure effects that would probably otherwise pass unnoticed.

Both perceptual and cognitive effects appear with either of the 2 kinds of homogeneous visual fields: (1) bright diffuse light, and (2) blackout. Thus, in the absence of normal patterned vision the important factor in the production of effects seems to be homogeneity of field, rather than intensity of stimulation. Significantly more perceptual distortion occurs with diffuse light stimulation than with the blacked-out visual field. There is no significant difference however, in the kind or amount of cognitive effects appearing under the two different conditions. Control subjects (social isolation alone) report essentially none of the effects in either category. There is no significant correlation in the appearance of the two different kinds of effects in the same subject. Gross perceptual changes may be recorded without concomitant cognitive changes and vice versa.

The visual imagery reported strongly resembles hypnagogic imagery in form, content, and mode of appearance.

Persons who normally experience hypnagogic imagery and who in general have rich visual experiences are more apt to report hallucinatory-like imagery in the sensory deprivation experiment.

A theoretic formulation is proposed that would attribute the perceptual distortions to the organism's continuous automatic search for order in a nonordered perceptual environment. The significance and limitations of these findings are discussed.

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Case Reports

Rupture of the Urinary Bladder

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RUPTURE OF THE URINARY BLADDER in the absence of either a history, or evidence, of external violence has been labeled "spontaneous." Virtually all the reported cases fall into 3 categories: those that occurred (1) during heavy muscular exertion, (2) in stuporous intoxicated persons, and (3) in the course of prolonged, difficult obstetric labor. A full bladder was invariably present. I was unable to find, however, a single instance in which rupture occurred in a rational individual, lying quietly in bed, under good nursing care, and with an apparently empty bladder, such as the case to be reported here. The association of abdominal wound dehiscence and uremia has been documented by others.[1]

CASE REPORT

A 51-year-old white man was readmitted to this hospital by transfer at 0200 hours 21 November 1959, because of acute pyelonephritis in a solitary right kidney containing a large stellate calculus in the inferior calix. His urologic difficulties had begun in 1942 when he underwent a left nephrectomy because of pyohydronephrosis with calculus. He was well until August 1959, when a canalized stone became impacted at the right ureterovesical junction, and a second stone was discovered in the remaining kidney. On 3 September only the ureteral calculus was removed, through a combined transvesical and retroperitoneal approach. Cystoscopy at that time failed to demonstrate either prostatic obstruction or abnormalities of the bladder. Convalescence was uneventful, the suprapubic fistula closing 20 September.

At 0200 hours on 20 November, the patient was awakened by acute, right-sided colic, accompanied by chills and fever. He was taken to his local Army hospital, where an intravenous urogram showed neither change in the renal stone nor evidence of a new one in the ureter, but poor concentration of dye in the kidney. His condition deteriorated rapidly and he was transferred to this hospital that night.

On admission he was acutely ill, in distress, with temperature 103° F. Aside from the 2 surgical scars, the only pertinent finding on physical examination was severe right costovertebral angle tenderness. His prostate gland rectally was within physiologic limits. He had an albuminuria of 3 plus, and the urinary sediment was loaded with innumerable white blood cells. The hemoglobin was

From the Urology Section, Walson Army Hospital, Fort Dix, N.J.

13.4 grams per 100 ml, leukocyte count 3,100 per cu mm, blood urea nitrogen 25 mg per 100 ml, uric acid 6.8 mg per 100 ml, and blood sugar 129 mg per 100 ml.

Shortly after admission the patient complained of great difficulty in voiding while reclining in bed, and an indwelling catheter was inserted at 0435 hours. The catheter drained freely all day, and was open at 1500 hours, when the drainage bottle was emptied. His urinary output then was 1300 ml. Shortly thereafter he suddenly experienced lancinating suprapubic pain, followed by a diffuse, progressive ache in the lower part of his abdomen. At 1600 hours it was noted that the catheter was no longer draining, and it was thought that the bladder was distended. The bladder was gently irrigated (for the first time since insertion of the catheter) with 20 ml of sterile isotonic saline solution. Although the catheter was not blocked, there was no return of the fluid. The surgical officer of the day, who was summoned, again irrigated the catheter gently once or twice. The time was then 1630 hours, and an appreciable suprapubic mass was already present.

At 1800 hours, still with no drainage, a sizable suprapubic mass could be seen. The patient was in considerable distress, although he had no desire to void and no sense of fulness in the bladder. The catheter was changed for another, which also did not drain.

At 2000 hours, when the attending urologist was called, the patient was in agony, with a huge, hot, exquisitely tender suprapubic tumor reaching above the umbilicus. The right paramedian scar was taut and livid. The catheter was changed for the second time, and irrigated. The only return flow was a little blood-flaked fluid. It was still thought that the mass represented distended bladder, the block produced either by a large clot filling the bladder or by a calculus impacted just above the vesical outlet. Although endoscopic evacuation of the bladder was considered, it was concluded, after deliberation, that another fragment of stone might be lodged at the ureterovesical junction, with rupture of the intramural segment of the ureter.

The abdomen was explored through a midline suprapubic incision. A massive urinary extravasation was revealed, with necrosis of the bellies of both rectus muscles and a large defect in the pelvic peritoneum exposing the cecum. The bladder was collapsed and the location of the tear not apparent, nor were any tears found in the ureter, which was examined from the brim of the pelvis to its entry into the bladder wall. A cystostomy was performed, the peritoneum repaired, and the abdomen closed with stab-wound drainage of the peritoneal cavity.

Postoperatively the patient ran an irregular, septic fever, with daily peaks between 104°F and 105°F. Intractable ileus developed requiring constant nasogastric suction. The preoperative incipient uremia progressed, the blood urea nitrogen reaching 73.2 mg per 100 ml by 29 November. Jaundice, apparent on 25 November, deepened rapidly, with serum bilirubin 4.8 mg per 100 ml by 27 November. The liver at this time was palpable 3 fingerbreadths below the costal margin. Throughout this period the patient's appearance belied the gravity of his condition; he was rational, actually cheerful, and perhaps even euphoric.

At 0800 hours on 2 December, the eleventh postoperative day, the laparotomy wound eviscerated. It was closed promptly with through-and-through sutures of steel wire. This time the original perforation was found in the right anterolateral aspect of the bladder, apparently through the original cystostomy scar. The site of the rupture and cystostomy was sutured with 000 chromic catgut. The pelvic peritoneum was intact, but the pelvic viscera were covered with a thick, tenacious,

purulent exudate. The pelvis was irrigated with a 0.1 percent solution of kanamycin sulfate, and a continuous drip of the solution was maintained through a polyethylene catheter. In addition, intramuscular administration of 250 mg of the drug twice daily was instituted.

Convalescence thereafter was uneventful. The patient became afebrile on the third day following repair of the dehiscence. His blood urea nitrogen was 44.5 mg per 100 ml on 3 December, and 21 mg by 9 December; the jaundice faded with equal promptness. The patient was discharged from the hospital 21 December, 31 days after admission. He had suffered a weight loss of 58 pounds.

In the follow-up clinic 1 month later the patient's urine was found to be heavily alkaline, with a specific gravity ranging between 1.005 and 1.018. His abdominal wall sagged markedly because of loss of muscle tone. On 24 January 1960, despite the fact that the patient had submitted to this procedure 8 times before with no ill effects, intravenous urography induced a severe syncopal attack, suggestive of peripheral vasodilatation. The study, nonetheless, was completed and proved to be unrewarding, except that the stellate calculus was still present. The patient was fitted with a supportive abdominal belt and allowed to return to work 1 February.

Between 1 February and 9 April he passed 3 more stones, each accompanied by mild right-sided colic. On 10 April, following a severe attack of colic and subsequent anuria, a calculus blocking the ureter 2.5 cm above the orifice was extracted. On 19 April a large stellate calculus lying free in the right renal pelvis was removed by combined pyelolithotomy and nephrolithotomy. Convalescence was relatively uneventful, the renal fistula becoming closed, after some delay, on 21 May. Postoperative endoscopy revealed no abnormalities of the bladder.

COMMENT

The cause of the rupture in this case is not easily explained. When the sequence of events on 21 November is reviewed, it is to be noted that the indwelling catheter had been draining freely all day, and that cessation of drainage followed by the appearance of the abdominal mass occurred after the patient's sudden attack of lancinating suprapubic pain. Irrigation of the bladder was now performed for the first time. Subsequently the site of the perforation appeared to be the previous cystostomy incision, now about 11 weeks old, which had apparently been completely healed 62 days before rupture.

I have personally cystoscoped a great many patients within 30 days after closure of the suprapubic fistula following open bladder surgery, and I have never been able to find the scar. This has been the experience of other urologists of my acquaintance. Furthermore, even in the aged, it is possible to overdistend a bladder with impunity by the fifth or sixth week after closure of the fistula. Finally, this patient underwent cystoscopy once before and 3 times after 21 November, and there was no evidence at any time of cellules, diverticula, or other abnormalities that might have contributed to the accident. Unfortunately, however, the bladder was not observed cystoscopically

between 3 September and 21 November, so that the possibility of a defect in the cystostomy scar, traumatized in some way by the indwelling catheter, cannot be completely ruled out. This case merits further interest because the patient survived a combination of ordinarily lethal complications.

SUMMARY

A case of rupture of the empty urinary bladder is reported. The patient's illness was precipitated by an acute pyelonephritis in a solitary kidney containing a large stone. Rupture apparently occurred through an old cystostomy scar, which presumably had closed completely 62 days previously. An indwelling catheter had been draining freely just before rupture occurred. Recovery was complicated by uremia, jaundice, and wound dehiscence, potentially lethal.

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Contact Glossitis From Autopolymerizing Resin Splint

LIEUTENANT COMMANDER HOMER S. SAMUELS, DC, USN

ACRYLIC RESINS have been used as denture material in this country for over 2 decades. The first of these to be so applied was composed of methyl methacrylate polymerized by heating. During the first 5 years of its use there were only occasional reports of allergic or appreciable soft tissue reactions. Peyton [1] observed that the reason for the tissue reactions, very small in number, was not known.

It was not long after this, however, that the dental profession began using autopolymerizing resins. Widespread application of these resins in a variety of oral procedures was accompanied by an increase in reactions. Although reports are not in agreement as to the actual irritating potential of the various ingredients,[1–5] it is now well

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recognized that the unpolymerized monomer is the major offender.[6-8]

It is often difficult to pinpoint the actual cause of the untoward reaction. The clinical manifestations—burn, eczema, bullae, stomatitis venenata,[9] or herpetic type ulcer—may be due to idiosyncrasy.[9-11] On the other hand, the heat of polymerization in situ may produce a frank burn. The severity of the phenomenon is governed by the degree of secondary bacterial or viral involvement of the weakened tissues.

The case presented demonstrates the reaction of the oral mucosa to autopolymerized resin used as a temporary dressing splint during the fabrication of an anterior fixed partial denture.

CASE REPORT

A 25-year-old white machine accountant, first class, was admitted to this hospital on 22 January 1960 because of painful gingiva and tongue. Four days before admission he had complained of pharyngitis, which subsided in 2 days. The gingiva and tongue became inflamed and increasingly painful, and multiple small ulcers appeared on the tongue. During this period the patient maintained a low-grade fever ranging up to 101° F. Oxytetracycline therapy for 2 days produced no improvement, and he was referred to this hospital.

Physical examination on admission revealed a well-developed, well-nourished man in some distress because of inflamed oral mucosa and inability to masticate his food satisfactorily. The midportion of the anterior dorsal third of his tongue was covered with multiple small punched-out yellow ulcers on an erythematous base (fig. 1). The alveolar gingiva in the area of the right lateral and central incisors was extremely inflamed. The posterior two thirds and lateral borders of the tongue and the remainder of the oral mucosa were completely uninvolved,

Figure 1. Appearance on admission, temporary methyl methacrylate splint in place. Note inflamed gingiva in vicinity of right incisors, and ulcers on erythematous tip of tongue.

Figure 2. Temporary splint removed. Notice proximity of tongue lesion to area under treatment.

Figure 3. Appearance 48 hours after removal of temporary splint.

Figure 4. Appearance of tongue 1 month later and after insertion of permanent fixed bridge constructed of heat-cured, full veneer crowns on gold copings.

demonstrating a better than average state of oral hygiene. There was a temporary methyl methacrylate splint in place on the right lateral and left central incisors, replacing a missing right central incisor. The remainder of the physical examination, including a roentgenogram of the chest and laboratory tests, was within normal limits.

Because the lesions were confined to a portion of the mouth in proximity to the temporary autopolymerized splint when the mouth was closed and in function, it was assumed that a chemical allergy or burn had occurred. The splint was removed (fig. 2) and the patient was placed on general supportive therapy with mouth rinses of hot normal saline solution. The splint was taped to the patient's chest as an initial patch test. By the following day the patient experienced marked relief of discomfort, and after 48 hours the oral condition showed dramatic improvement (fig. 3). The skin of the test site on the chest was unaltered. By 25 January the only remaining abnormality was atrophy of the lingual papillae in the affected area. The patient was asymptomatic, afebrile, and able to masticate a regular diet.

The patient was seen again on 7 March, when in cooperation with the dermatology service, additional patch tests with the previously employed material were initiated. The monomer and polymer were applied individually to separate areas of the skin of the back. In addition, a plastic mix was prepared and allowed to polymerize in an edentulous mandibular molar area, using a figure-of-eight wire around the adjacent teeth for retention. At the end of 48 hours the test sites revealed no significant reaction of the skin or oral mucosa. By this time a heat-cured, fixed prosthesis had been inserted and was well tolerated (fig. 4).

DISCUSSION

Although presumptive patch tests were negative and a similar untoward reaction could not be repeated in a test site in the patient's mouth, the location and distribution of the lesion strongly implicates the resinous material. Although the precise cause of this phenome-

non cannot be advanced with certainty, one may theorize that one or several factors were at optimum levels to permit this insult.

A likely and most variable factor is that of oral dehydration. We may conjecture that the mouth may have been kept open and dry during preparation of the bridge abutment, so that the tongue was deprived of the diluting effect of the saliva and was thus more susceptible to irritants. Other variable factors are the ratio of monomer to polymer, total bulk of material used, and pH of the resulting combined oral environment.

In the absence of any positive response to the sensitivity testing, we may only assume that the herpetic-like ulcers were caused either by the thermal heat of polymerization of the greater bulk of material in the temporary splint or by an allergic response occurring under certain optimal conditions that could not be duplicated.

SUMMARY

An acute, markedly circumscribed reaction occurred on the tongue in close proximity to a temporary acrylic splint used during fabrication of a fixed partial denture. The affected area cleared upon removal of the splint. Patch tests for sensitivity to unpolymerized monomer were negative.

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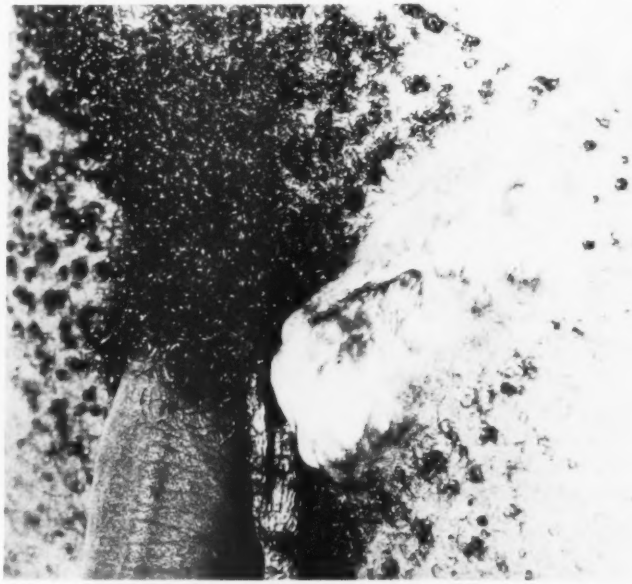
Case for Diagnosis

HERBERT B. TAYLOR, M.D.

A 23-year-old man had noted a slowly enlarging firm nodular mass below the inguinal ligament for 10 to 12 years. During recent months growth had been more rapid, and the mass was tender to pressure. Examination showed a bosselated mass fixed to the skin, yet movable over the deeper tissues and without ulceration.



Diagnosis?

Please turn the page.

From Armed Forces Institute of Pathology, Washington, D.C. This month's Case for Diagnosis is AFIP Accession No. 484835, contributed by Letterman General Hospital, San Francisco, Calif.

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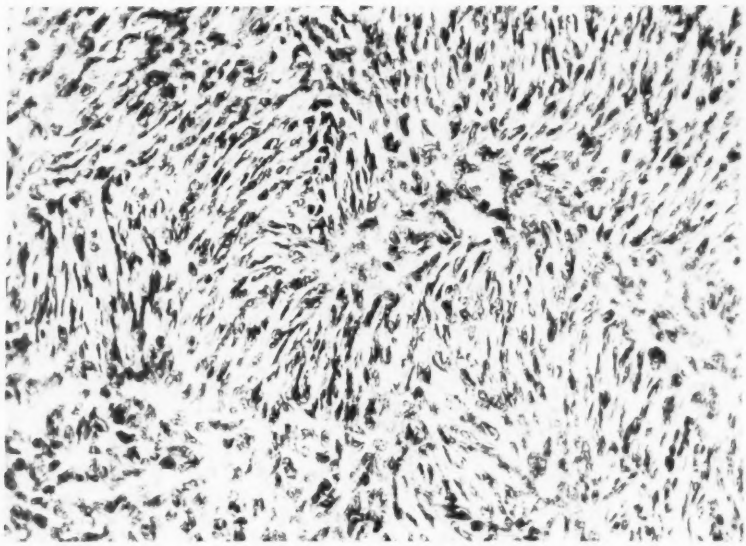
Discussion and Diagnosis

The clinical history of a nodular intracutaneous mass involving the trunk or proximal portions of the extremities, usually present for a number of years with little change and then enlarging rapidly, is typical of this lesion. Approximately 50 percent of the cases recur one or more times following excision, and in very rare instances distant metastasis occurs.



The histopathologic changes of the lesion are usually described as indistinguishable from cellular fibroma or fibrosarcoma elsewhere in the body. A study of the cases on file at the Armed Forces Institute of Pathology indicates that the whorled "cartwheel" arrangement of spindle cells is characteristic of dermatofibrosarcoma protuberans and permits an objective diagnosis to be made.

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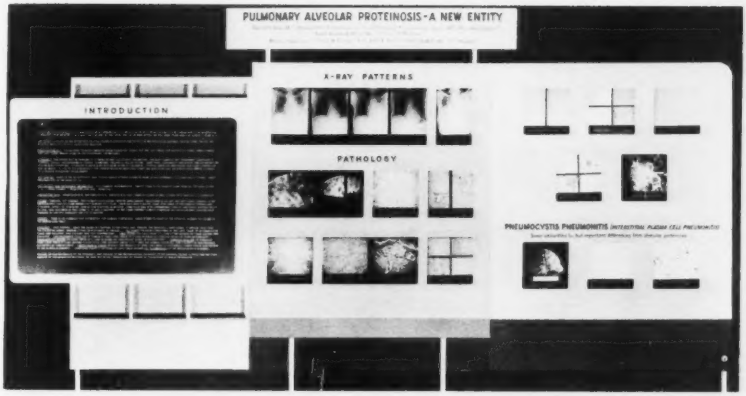

Scientific Exhibit

Pulmonary Alveolar Proteinosis

SAMUEL H. ROSEN, M.D.

IN JUNE 1958 we published a report [1] on 27 cases defining an apparently new disease of the lungs resembling, but—we believe—distinct from *Pneumocystis carinii* infection (interstitial plasma cell pneumonitis, figs. 15–18). We tentatively named it "pulmonary alveolar proteinosis" because of the proteinaceous appearance of the material filling alveoli, the usual absence of inflammatory reaction, and our ignorance of the etiology. Since that report 23 additional cases have been studied at the Armed Forces Institute of Pathology, including one with onset in 1946 or 1947 and another with probable onset in 1949. It would appear, therefore, that the disease has been with us longer than we suspected (13 or 14 years, or possibly even longer) and that although at first very sporadic, it has since about 1953 occurred with increasing frequency.

From the Central Laboratory for Pathologic Anatomy and Research, Veterans Administration, Armed Forces Institute of Pathology, Washington, D.C. Adapted from an exhibit by S. H. Rosen, B. Castleman, and A. A. Liebow last presented at the 108th Annual Meeting of the American Medical Association, Atlantic City, N.J., June 8–12, 1959; with additional material presented by S. H. Rosen at the 26th Annual Meeting of the American College of Chest Physicians, Miami Beach, Fla., June 8–12, 1960.

This was planned as the first of a series of scientific exhibits prepared by the Medical Illustration Service of the Armed Forces Institute of Pathology and adapted for the *Journal*.—EDITOR

Pathology

The lesion consists of the filling of alveoli and peripheral bronchial passages with a periodic acid Schiff (PAS)–positive, granular, and floccular proteinaceous material, rich in lipids, with little, if any, associated reaction in lung or pleura (fig. 5). Grossly, the lungs are heavy and diffusely involved by small foci or large confluent areas of gray-white or yellow-gray consolidation (figs. 3 and 4).

Roentgenography

The bilateral, usually perihilar, radiating soft shadows simulate the "butterfly" pattern of severe pulmonary edema, but they may persist for months or years, during which they may remain more or less stationary, or progress, or undergo partial clearing followed by recrudescence (figs. 1 and 2). Cardiac enlargement, pleural fluid, significant hilar adenopathy, cavitation, and calcification are *not* features of uncomplicated alveolar proteinosis.

Clinical Manifestations

The disease may be heralded by a febrile illness suggesting pneumonia, but often the onset is insidious, with few or no symptoms. Recurrent febrile episodes of "pneumonia" or "flu" are a feature of many cases. The most common complaint is dyspnea, usually accompanied by cough, sometimes yielding a yellow or white sputum. Chest pain, fatigability, and slight loss of weight are less frequent symptoms. Cyanosis and clubbing are uncommon and generally associated with more severe involvement. Physical signs on percussion and auscultation are remarkably few or absent.

Age, Sex, and Race

Most of the patients have been between 20 and 50 years of age. The oldest was 65 years, and there were 2 children, a boy of 2½ years and a girl of 7 years. Males predominated in the ratio of 2 to 1. Of our 50 cases, 4 were Negroes (2 males and 2 females).

Occupation and Geographic Distribution

There is no common denominator. Although more than one fourth of the patients have been exposed to dusts, sprays, or fumes of various kinds in their occupations, there is no evidence incriminating any one of these. The disease has a wide geographic distribution, apparently unrelated to climate.

Laboratory Findings

These have not been contributory, although some were recurrent. There has been a tendency to secondary polycythemia. Serum proteins were slightly increased (up to 9.0 grams) in at least 6 cases, with a shift toward unity of the albumin-globulin ratio in 7 cases and an actual reversal of the ratio in 4 cases. Various globulin fractions were somewhat elevated in all of 8 cases in which electrophoretic studies were available. A marked increase in total blood lipids was reported in 5 cases, with normal values in 2 cases. Blood cholesterol was slightly to moderately increased in 4 of 11 cases. In 3 cases the elevation of blood lipids seemed to be associated with clinical and roentgenographic improvement, suggesting that this finding might have been the result of resorption into the blood stream of the proteinaceous material with its high lipid content.

Pulmonary Function Studies

Certain tests of pulmonary function reported in 23 of our cases indicated some impairment in most, usually slight to moderate, and in a few more severe, with evidence of the restrictive type of ventilatory insufficiency. Vital capacity was decreased in most patients, from slightly to markedly (1.2 to 4.3 liters per minute). Maximal breathing capacity ranged from 50 to 100 percent of normal, in most cases being close to normal. Arterial O_2 saturation was slightly to moderately decreased, but became normal or nearly normal on breathing O_2, suggesting impairment of alveolar capillary diffusion. In a few instances there was some indication that increased venous admixture or physiologic shunting also played a part in the hypoxia.

Course

On the basis of all our 50 cases, including follow-up in 8 of the original series of 27, the course is chronic but variable: Seven patients have shown definite clinical and roentgenographic improvement over periods of 25 months to almost 5 years. Four patients have shown apparent recovery both symptomatically and roentgenographically after periods ranging from 18 months to 5 years at last follow-up. In 2 of these, repeat lung biopsies supported the impression of recovery. Three patients were asymptomatic at the time of discovery of the disease on routine chest roentgenogram. One developed mild symptoms after 4 years, and another developed mild symptoms after 4 months. In 15 instances there was persistence of symptoms and roentgenographic changes in varying degrees for periods of 3 months to 11 years or more at last follow-up. Symptoms were generally mild, so that at least 7 of these patients were able to carry on their work adequately.

Of the total of 50 cases there have been 15 known deaths (30%), some with progressive dyspnea and cyanosis, after 3 to 10 months in 4 cases, 1 to 2 years in 9 cases, and 3 to 4 years in 2 cases. In 9 of the 15 deaths (60%), there were associated pulmonary complications, as follows: fungous infections in 3 (*Nocardia* 2, *Cryptococcus* 1); diffuse interstitial pneumonitis in 3; bronchopneumonia in 2; giant cell or Hecht's pneumonia in 1; acute illness of undetermined nature in 1.

If we discount the deaths associated with pulmonary complications, we may assume that only 5 deaths (or 10% rather than 30% of the 50 cases) were attributable to the alveolar proteinosis itself.

Therapy

We know of no definitive treatment nor, in fact, is there any adequately proved effective treatment. However, in 3 cases marked improvement or recovery, both symptomatic and roentgenographic, occurred while the patients were receiving iodides. In at least 2 or 3 instances administration of prednisone was associated with improvement. Treatment with Alevaire and Isuprel nebulizer was reported to produce definite improvement in 2 cases.

Since we have thus far had no indication that the alveolar proteinaceous material in this disease undergoes organization, further therapeutic efforts directed toward softening or liquefying this material so that it may be expectorated or absorbed would seem to be indicated.

Prognosis

Although much longer follow-up is needed for reliable prognosis, it would seem at the present time, on the basis of our figures and without benefit of definitive treatment, that the prognosis for long survival with relatively little incapacity is

fairly good, provided serious pulmonary complications can be avoided.

It also seems that spontaneous recovery with few or no residua may occur in some instances—possibly 4 in our series of 50. However, in view of what appears to be a characteristic tendency for this disease to undergo remissions and exacerbations over years, it is premature to offer anything more than a guarded prognosis as far as recovery is concerned.

Diagnosis

A definitive diagnosis still depends on lung biopsy. Needle biopsy would seem to warrant consideration since there is no indication that the disease might spread as the result of such a procedure. Repeated examination of the sputum for amorphous granular material (fig. 5), granular septal cells (fig. 7), acicular crystals (fig. 11), and laminated bodies (fig. 12) might yield diagnostic information. A presumptive diagnosis of alveolar proteinosis can be and has been made on the characteristic roentgenographic pattern and the disproportion between the extensive bilateral roentgenographic involvement and the few symptoms and signs.

Etiology

Unknown. Since the lesion is confined to the lungs, and possibly the draining lymph nodes, it appeared likely that the causative agent was inhaled, but there is no clue to such an agent, either living or inanimate. We inoculated guinea pigs and mice with a suspension of fresh-frozen lung tissue from one case, subcutaneously, intraperitoneally, and intranasally, with negative results. Stains, cultures, and the usual animal inoculations for microorganisms, virus studies by the method of tissue culture (3 cases), spectrographic analysis (2 cases), and radioactivity studies (3 cases) of diseased lung were all unrevealing. Chemical analysis of formalin-fixed lung tissue (2 cases) showed a high total lipid content (about 5 to 7 times the normal control) and a slight or questionable elevation of carbohydrate. Histochemical studies revealed the presence of lipids (including cholesterol), carbohydrate, and protein in the alveolar content. The proteinaceous material gave a negative reaction for fibrin with phosphotungstic acid–hematoxylin (PTAH) stain, showed metachromasia with toluidine blue, which was enhanced by sulfation and abolished by methylation, and did not fluoresce.

We have observed a localized reaction indistinguishable from alveolar proteinosis in a variety of pulmonary lesions, inflammatory and neoplastic (figs. 13 and 14), which seems to lend support to our earlier suggestion [1] that alveolar proteinosis may be a type reaction occurring in response to a variety of agents rather than a specific reaction to one agent. This would not eliminate alveolar proteinosis as a disease entity: an analogy with the sarcoid reaction and its relationship to sarcoidosis as a clinical entity suggests itself.

The possibility that alveolar proteinosis is a type of immune reaction in response to either exogenous or endogenous antigenic substances would seem at this juncture to merit more serious consideration.

ACKNOWLEDGMENT: Special thanks are due Mr. Herman Van Cott, Chief, Medical Illustration Service, Armed Forces Institute of Pathology, and his staff for their cooperation and technical assistance in planning and illustrating the exhibit from which this article was adapted.

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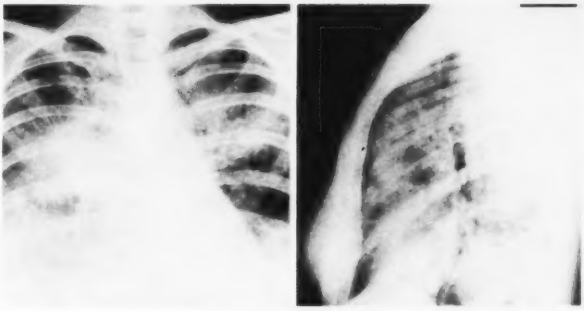


Figure 1. Characteristic roentgenograms. Hilar "butterfly" pattern (*left*) is frequent one. Lack of significant hilar adenopathy (*right*) is also typical. AFIP 786301.

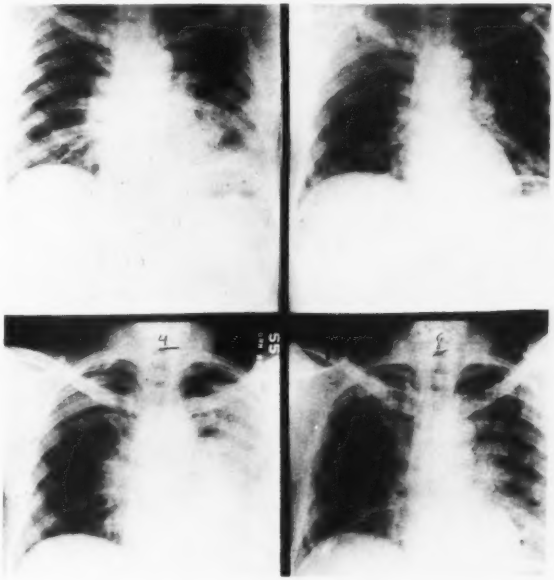
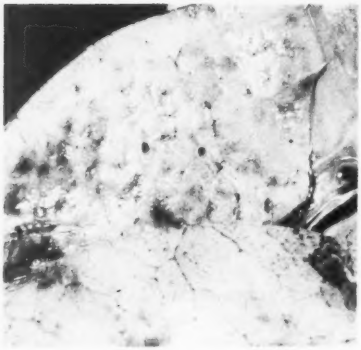


Figure 2. Films illustrating frequent sequence. Heart shadow normal in all. (*Upper left*) At onset: characteristic hilar "butterfly" pattern. (*Upper right*) 8 days later: marked clearing of lung fields. (*Lower left*) 3 months later: recurrence, with more extensive involvement than at onset and with coalescence in left lung field. (*Lower right*) Almost 2 years later: only slight residual pathology in both bases. AFIP 833429.



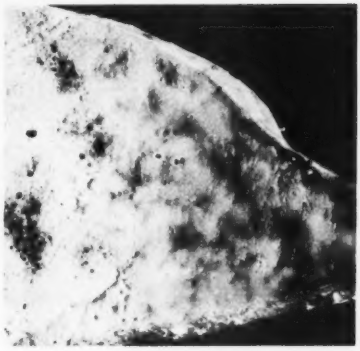
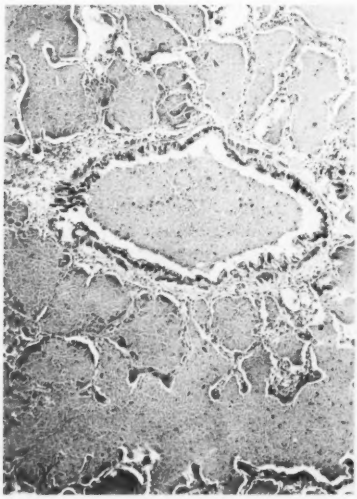


Figure 3 (*left*). Lung (autopsy). Massively consolidated and heavy. Pleura normal (bottom). AFIP 851936.

Figure 4 (*right*). Lung tissue (surgical). Multiple foci of consolidation becoming confluent. Intervening emphysema. AFIP 814530.



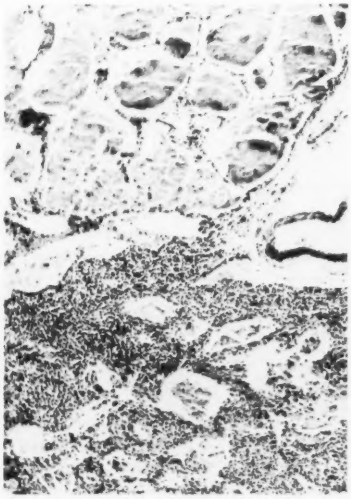


Figure 5 (*left*). Characteristic but probably not earliest lesion. Alveoli and bronchiole filled with granular and floccular "proteinaceous" material. Alveolar walls thin and without infiltration; bronchiole also free of inflammatory change. (Hematoxylin and eosin, x 90.) AFIP 851936.

Figure 6 (*right*). From biopsy performed about 4 years after apparent onset. Whether interstitial infiltration and fibrosis, such as focus at bottom, are phase of alveolar proteinosis or—as we believe—incidental finding due to antecedent or complicating pulmonary disease, is still undecided. (Hematoxylin and eosin, x 50.) AFIP 825391.

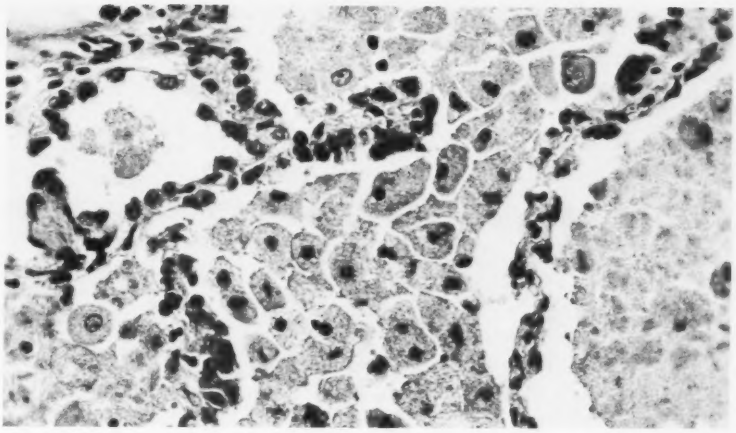
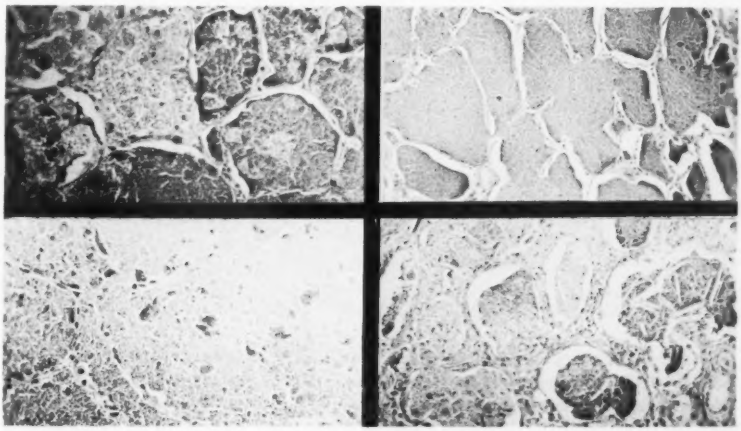


Figure 7. Field believed to represent early stage in evolution of alveolar proteinosis. Alveolar septal cells multiply, swell, become granular and some vacuolar (lipid), desquamate, and disintegrate to form "proteinaceous" material. (Masson trichrome, x 330.) AFIP 750958.



Figures 8, 9, 10, 11. Granular and floccular "proteinaceous" material as well as granules of necrotic, disintegrating septal cells is strongly PAS positive. Acicular crystal spaces (fig. 11, *lower right*) are common finding. Thickening of alveolar walls with large mononuclear cells (fig. 11) is not characteristic. (PAS, x 200, x 100, x 300, x 130.) AFIP 814530 and 750598.

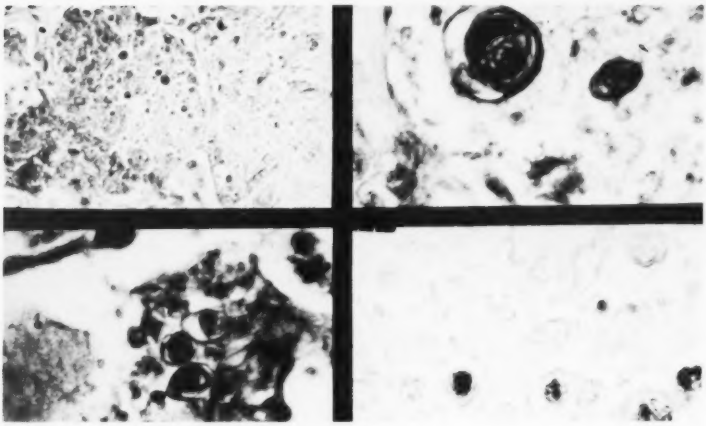
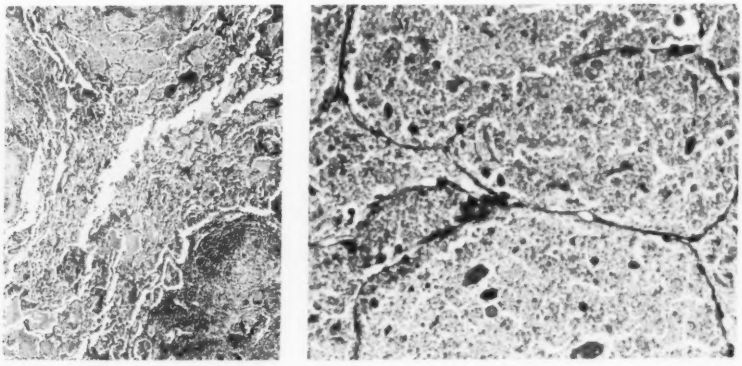


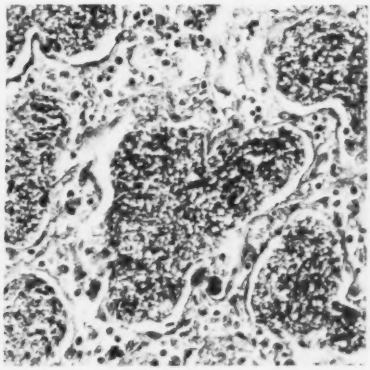
Figure 12. "Laminated" bodies of variable size are frequent finding, believed to represent residues of septal cells with deposits of proteinaceous material. We have seen similar or identical bodies in lung diseases other than alveolar proteinosis. (PAS, x 500, PAS, x 1720, hematoxylin and eosin, x 1500, Masson trichrome, x 1400.) AFIP 786301 and 825391.



Localized Alveolar Proteinosis Reaction

Figure 13 (*left*). From solitary 2-cm lesion in lung. At bottom, focus of conglomerate miliary granulomas with Langhans' giant cells. At top, area indistinguishable from alveolar proteinosis. Between these, alveolar edema. (Hematoxylin and eosin, x 25, reduced by 1/2.) AFIP 884615.

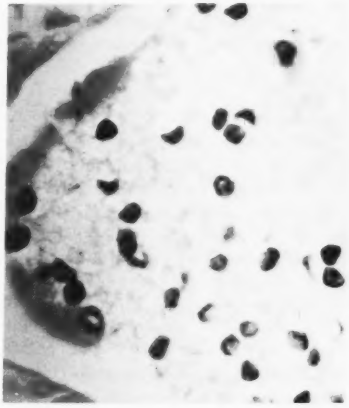
Figure 14 (*right*). Higher magnification of area indistinguishable from alveolar proteinosis in figure 13, giving positive reaction with PAS. Acid-fast stain and fungus stains were negative on this lesion as well as on granulomatous lesion. (PAS, x 150.) AFIP 884615.



Pneumocystis Pneumonitis (Interstitial Plasma Cell Pneumonitis)
(Some similarities to—but important differences from—alveolar proteinosis)

Figure 15 (*left*). Lung tissue of pneumocystis pneumonitis from female infant who died at 10 weeks of age. Consolidation similar to alveolar proteinosis (compare with figure 4). AFIP 802460.

Figure 16 (*right*). Characteristic reticular or foamy PAS-positive intra-alveolar material and thickened alveolar walls infiltrated with plasma cells of pneumocystis pneumonitis differ from characteristic PAS-positive granular alveolar contents and thin alveolar walls of alveolar proteinosis (compare with figures 5, 9, 10). (PAS, x 200.) AFIP 802460.



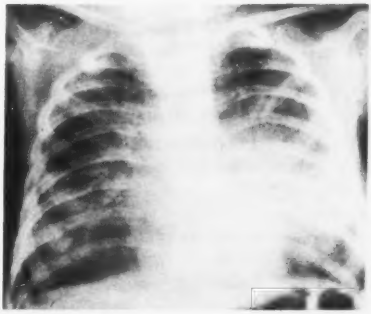


Figure 17 (*left*). Gomori-Grocott methenamine–silver nitrate technic shows many *Pneumocystis carinii* organisms in foamy alveolar contents of pneumocystic pneumonitis, in contrast to their consistent absence in granular alveolar contents of alveolar proteinosis. (Oil, x 1700.) AFIP 802460.

Figure 18 (*right*). Roentgenographic appearance of pneumocystis pneumonitis resembles that of alveolar proteinosis (see figures 1 and 2). AFIP 756177.

Technical Notes

Technics for Bacteriologic Studies of Field Specimens

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JIMMY R. EVANS, M.S.
LIEUTENANT COLONEL HINTON J. BAKER, MC, USA

IN THE PAST, bacteriologic study of valuable clinical material during field tests has been hampered by the lack of technical facilities and personnel for processing specimens at the test sites. In support of the biomedical program, Project 4.1, Operation Plumbbob, conducted at the Nevada Test Site in 1957,[1] specimens collected during field testing were transferred elsewhere for laboratory study. The technics used may well be utilized in future field studies.

During a 21-day observation period, 1,523 specimens were taken from swine after their exposure to the effects of a nuclear device in a simulated "built-up" environment. The specimens, packed with dry ice, were shipped by air more than 2,000 miles for processing in a modern laboratory where qualitative and semiquantitative studies were performed.

MATERIALS AND METHODS

Materials used in the field were standard machine-rolled cotton-tipped wooden applicators, 4-ml screw-capped vials containing 1.0 ml of 1 percent gelatin dissolved in M/15 phosphate buffer pH 7.0, 18 ml screw-capped test tubes, dry ice, an insulated box (fig. 1), and a roller device for shell freezing of specimens (fig. 2). Materials used in the laboratory were platinum loop, 0.01 ml (Fisher Scientific Company No. 13–103), standard glassware, and culture media (obtained from Baltimore Biological Laboratory, Inc., Baltimore, Md., except the egg-meat medium, which was obtained from Difco Laboratories, Detroit, Mich.).

Preparation of Specimens

Blood. Skin was cleansed and treated with iodine before venipuncture. Two ml of blood was taken in a heparinized syringe and delivered to a sterile screw-capped test tube, in which it was shell frozen within an hour and stored in dry ice for shipment. The roller device depicted in figure 2 was partially submerged in an ethyl alcohol–dry ice bath. The rollers are usually operated by electricity,

From Walter Reed Army Institute of Research, Washington, D.C.

Figure 1. The insulated box.

but they can be turned manually.

Wound and feces specimens. These were taken by inserting the machine-rolled swabs deep into the wound or feces until the swab was saturated. The cotton tip was broken off into the 4-ml screw-capped vials containing the buffered gelatin. The tube contents were shaken and shell frozen within an hour.

Necropsy specimens. These were taken from animals that were necropsied less than 2 hours after death. Heart blood was taken by syringe and needle through the seared heart surface. Cultures of tissue specimens were taken with sterile swabs after searing the tissue surface and puncturing the center of the seared area with a flamed scalpel. Swabs were pushed into the tissue and rotated until some tissue juice had been absorbed. The swabs then underwent the same process as those used for the wound and fecal cultures.

Solutions tested for best survival rate of bacteria after the shell freezing and thawing process included physiologic saline solution, trypticase soy broth, veal infusion broth, human serum albumin suspended in saline or M/15 phosphate buffer, and a number of concentrations of gelatin suspended in M/15 phosphate buffer at varying pH values. Most of these were satisfactory except for the preservation of coliform bacteria. Our final choice—1 percent gelatin in phosphate buffer—was not completely satisfactory, but its loss of only one log of coliform bacteria in 2 weeks proved it to be superior to other media tested.

Studies on the refrigeration qualities of dry ice in the insulated boxes shown in figure 1 showed that such a box filled one half with specimens and the other half with dry ice would remain frozen for at least 40 hours without re-icing. All specimens were still frozen upon arrival at the processing laboratory, where they were immediately catalogued.

Culture Media

Our choice of culture media, admittedly arbitrary, was as follows:

Blood cultures.
- 0.1 ml in blood agar base pour plate for aerobic incubation
- 0.1 ml in blood agar base pour plate for anaerobic incubation
- 1 ml in 10 ml cooked meat broth

Wound cultures.
- Violet red bile for isolation and enumeration of gram-negative bacteria
- Blood azide agar for counting gram-positive aerobic bacteria
- Blood azide egg yolk agar incubated anaerobically for counting clostridia capable of precipitating lecithin
- Egg-meat medium

Fecal cultures. Same as for wound cultures except that the aerobic blood medium did not contain azide.

Necropsy cultures.
- Blood agar aerobic incubation
- Blood agar anaerobic incubation
- Blood azide agar anaerobic incubation
- Egg-meat medium

Technic

Conventional quantitative studies of the wound, fecal, and necropsy specimens processed in this study would ordinarily require a lengthy and expensive endeavor. A modified technic was developed so that approximate bacterial counts of the specimens could be obtained on a single plate. Briefly, this technic consisted of spreading one 0.1 ml loopful of specimen (considered a 1/10 dilution) evenly over one half of an agar plate 100 mm in diameter. A subsequent 5-cm streak from the spread area provided material for streaking one of the remaining quadrants and, in turn, a 2.5-cm streak from that quadrant provided material for the streak-

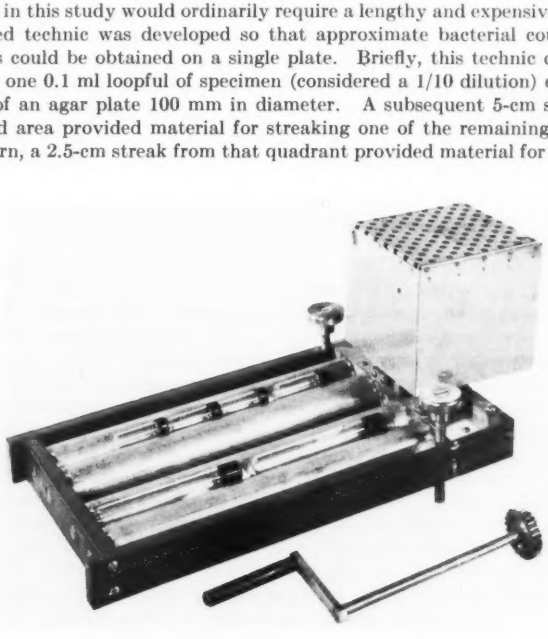

Figure 2. The roller device for shell freezing of specimens.

ing of the remainder of the plate. Estimation of the amount of growth in each area of the plate enabled us to estimate bacterial counts ranging from 10^3 to 10^8 organisms per ml of original specimen. This serial dilution streak-plate method was further refined by Lindsey, who has described it in detail.[2] These same plates were used for primary isolation of bacteria. Organisms not readily identifiable were preserved in cystine trypticase agar or in egg-meat medium until the "production line" phase of processing the samples was completed.

DISCUSSION

The technics presented here are designed to utilize a limited amount of simple, light, compact materials and equipment, necessary in the field for collecting and shipping. Cumbersome, heavy, sometimes delicate, and expensive laboratory equipment remains in the base bacteriologic laboratory, where the specimens are cultured. In the interest of efficiency, an advantage can also be claimed for the personnel in that those best trained at bacteriologic technics can work with the specimens under the more favorable conditions of a well-established laboratory. The personnel required for collecting cultures under field conditions should be trained in this technic but do not have to be qualified bacteriologists.

The methods presented here can provide an estimate of the number of bacteria present at the site of culture as well as a broad survey of the types of bacteria. Large numbers of cultures for a survey study can be handled in a short time by a relatively small laboratory group. It is expected that these methods can be improved. The essential concept, however, is that a well-established military base laboratory can carry out a large-scale bacteriologic survey several thousand miles away with relatively simple logistics.

SUMMARY

Technics are presented by which large numbers of clinical specimens can be taken under field conditions and processed at a distant laboratory under ideal conditions. Within limits, results from such studies can be quantitative as well as qualitative.

REFERENCES

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2. Lindsey, D.: Quantitative bacteriologic study of tissues, fluids and exudates; some simplified methods. *J. Lab. & Clin. Med.* 53: 299–307, Feb. 1959.

Rapid Method for Obtaining Packed Red Blood Cells

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SPECIALIST 4 FRANK THARP, USA

AT PRESENT the standard item for blood banking in the Armed Forces is the "Blood Collecting and Dispensing Bag with Integral Donor Set," stock #6515–664–2734. When a need for concentrated red blood cells arises, elimination of plasma from this bag is ordinarily accomplished by the use of the transfer pack or the double pack. Both these packs are nonstandard items, not readily available to the small, isolated military hospital.

Although the transfer pack method as published by its suppliers makes efficient use of blood components, none of the published procedures provide for the elimination of plasma without the use of accessory equipment. We evaluated—and discarded—alternate methods, such as insertion of donor sets or needles through the diaphragm openings, because they lack simplicity and present a greater probability of contamination when the blood container is entered.

The procedure set forth is primarily for the small service hospital laboratory that utilizes the standard plastic bag. Such a laboratory would be faced with the problem of concentrating erythrocytes in order to meet requirements of the hospital physician. The procedure could be considered in the absence of a transfer set whenever concentrated red blood cells were required but unavailable from another source.

METHOD

The method described here has been used successfully by this laboratory and other armed service laboratories in the Far East for the past 6 months. *As a precaution against bacterial growth, this procedure can only be performed immediately before the transfusion; the concentrated red blood cells must* NOT *be stored for future use.* The blood must be well packed by gravity or the proper size centrifuge must be available for packing the erythrocytes by centrifugation.

1. Prepare a clean working area and have the following articles ready for use: receptacle for the blood plasma, hemostat, sterile scissors, pressure clamp, if available, for squeezing the plastic bag, and heavy suture thread or adhesive tape.

2. Tie a loose overhand knot in the remaining length of donor tubing. If a dielectric sealer has been used, this cannot be done because the length of tubing between the last seal and the bag will be too short. The knot can be omitted if the donor tubing is too short.

From the Serology & Blood Bank Department, Medical General Laboratory (406), U.S. Army Medical Command, APO 343, San Francisco, Calif.

3. Place and lock the hemostat on the donor tubing line between the seal and the bag, and close to the last seal.

4. Cut the donor line between the hemostat and the last seal or knot.

5. Exert positive pressure on the plastic bag with the pressure clamp or with one or both hands. A small commercial V-shaped clamp is available, and can be used to provide uniform and controlled positive pressure. A similar clamp can be made by hinging 2 boards together.

6. Release the hemostat and force the plasma to flow out. The plasma is now contaminated and must be discarded.

7. Continue positive pressure until the desired concentration has been achieved.

8. *At no time can flow be allowed to cease unless the hemostat is clamped shut. Relaxation of pressure will cause contamination.*

9. When the plasma has been eliminated, clamp the hemostat and then seal the donor line by tightening the knot, or by use of a dielectric sealer if available.

10. If the donor line is too short to tie and the sealer is not available, the hemostat may be left on the bag and securely taped; or the tubing may be bent against itself and tied tightly with a heavy suture thread or taped with adhesive tape.

DISCUSSION

This method was developed to eliminate, insofar as possible, many of the technical problems faced by the small military laboratory blood bank when an emergency request for concentrated red cells arises. As long as positive pressure and, therefore, plasma flow is maintained, the problem of contamination is a minimal one. No entry into the bag is made, no diaphragm is penetrated, and the knot, seal, hemostat, or tie reestablishes the original sealed condition of the bag.

A technician can perform this operation in a very short period of time, although 2 technicians working together eliminate the possibility of a mishap during the squeezing and clamping period. The technicians must be alert at all times to prevent loss of pressure and subsequent contamination. Because of the method's simplicity, the ward or clinic physician may perform the concentration if the decision to give packed cells is made after the blood has been received, provided, of course, that layering still exists, or that sufficient time can be allowed for resettling by gravity.

SUMMARY

A rapid, simple method for concentrating red blood cells in plastic bags has been presented. The method consists of a simple reopening of the original donor tubing, extrusion of plasma by pressure, and resealing of the exit.

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Activities of the Commission on Viral Infections

WILLIAM MC D. HAMMON, M.D.

THE COMMISSION ON VIRAL INFECTIONS focuses its interest on the prevention of those virus diseases believed of greatest importance to the military, particularly during times of war when deployment may occur almost anywhere in the world. The Commission does not concern itself with those viral infections specifically assigned to other commissions, notably influenza and acute viral respiratory infections. Agents receiving maximum attention at present are the hepatitis viruses, measles virus (a recruit problem), and the very large group of arthropod-borne viruses (Ar-bo viruses).

The Commission's scope of activity within its field of interest includes making available expert consultation services to the preventive medicine divisions of the armed services in Washington on policy matters or in the preparation of technical directives. It also furnishes consultation or assistance, on request, to any Armed Forces installation anywhere in the world. Emergency field investigations of epidemics, or long-term studies of endemic or repeated epidemic situations are frequently undertaken by civilian teams recruited by Commission members. These epidemic or endemic disease problems may involve military personnel only, or civilian populations near military posts.

Laboratory research is undertaken by Commission members, or on their recommendation by contract with other research groups. This may be for relatively basic research, for development of methods and technics for virus isolation, diagnosis, and survey, or for testing specimens collected in field investigations. In addition to these activities, this Commission reviews the research programs on related problems as carried out directly by the special research teams of the armed services (the Naval Medical Research Units, Walter Reed Army Institute

From the Commission on Viral Infections, Armed Forces Epidemiological Board, Washington, D.C. Dr. Hammon, Director of this Commission, is at the Graduate School of Public Health, University of Pittsburgh, Pa.

Other articles in this AFEB series, originally scheduled for publication in the *Journal*, will appear in *Military Medicine*.—EDITOR.

of Research, and their branches in Japan and Malaya; and the Air Force Epidemiological Laboratory, Lackland Air Force Base, Texas) and the U.S. Public Health Service (National Institutes of Health and Communicable Disease Center groups) in an attempt to promote communication, serve in a consultation capacity, promote teamwork, and assist in avoiding duplication of effort. Promotion of communication and coordination has in several instances extended well beyond the armed services and the U.S. Public Health Service, with important results.

Dr. John Enders and his associates in a Commission-sponsored program were the first to devise a practical method for isolation of the measles virus, produce it in quantity, attenuate it, and develop diagnostic serologic tests and tests to evaluate immunity status. An attenuated measles virus vaccine is in experimental use, evaluation proceeding in child volunteers under supervision of several Commission teams and other cooperating investigative groups.

Hepatitis of both the infectious (IH) and serum (SH) types has proved to be a most baffling and discouraging problem because of the failure of all investigators to demonstrate the presence of virus without use of human volunteers. For this reason the Hepatitis Subgroup of this Commission, under the direction of Dr. John R. Paul and consisting of members from Yale, Jefferson, Johns Hopkins, University of Pennsylvania, New York University, University of Southern California, and the National Institutes of Health, is a large coordinated team representing most of the research groups in the United States making a major effort in these diseases. They are attempting to grow both types of virus in a great variety of tissue cultures and organ cultures of human embryos (laboratory established in Denmark), as well as to demonstrate disease in untried laboratory animals (several large trials in chimpanzees in the Belgian Congo), and are performing fluorescent antibody studies and electron photomicrography of ultrathin sections of a large variety of tissues representing tissue and organ cultures, human biopsy, and autopsy materials. Tests of blind tissue culture passage materials have been made in human volunteers. Gamma globulin in the prevention of both types of icteric disease is under more detailed investigation than previously, and its effect on subicteric infection is also being measured. Active-passive immunization is also under trial. Improved methods of diagnosis of both the icteric and subicteric infections are being developed and tested, including a battery of enzymes and a hemagglutinin for chick erythrocytes. Epidemic assistance and consultation were given the Navy in epidemics observed on ships out of Naples harbor.

Another coordinated approach is directed at the epidemiology and control of the Ar-bo viruses. This research group, composed of representatives from the University of Pittsburgh, University of Minnesota, Yale University, and University of Cincinnati, have recently isolated and identified a number of new viruses and the causes of several new epidemic diseases. The viruses include Sagiyama I, Mag 115, and M7/270 from Japan; dengue types 2, 3, and 4; a chikungunya-like agent, P–422 and P–581 from the Philippines; and T–96 from Thailand. New diseases are Philippine hemorrhagic fever found to be caused by dengue types 3 and 4, and Thai hemorrhagic fever in which dengue type 2 and chikungunya-like viruses were etiologically involved. Diagnostic and field survey methods are being improved. Tissue culture, of practically no value in this virus group before, has been rapidly developed; many relatively new tissues have found a valuable place and have been measured for comparative value for virus isolation, neutralization tests, and production of complement-fixing and hemagglutinating antibodies. Tissue culture usage has also been developed for plaque formation. This has many advantages over other methods of quantitation and single infectious particle selection. Encouraging progress is being made in improved Japanese B encephalitis virus vaccines by use of tissue cultures, including attenuation of virus for a possible living virus vaccine. Mosquito transmission experiments with new agents is part of the program in one laboratory.

In coordination of efforts, the greatest accomplishment of the Ar-bo group is the successful action achieved through a formal recommendation made to the Rockefeller Foundation for the organization of a committee of outstanding American investigators in this field to promote communication, coordination of research, and selection of a central virus reference laboratory. This culminated in a "Gould House Conference," organized by the Rockefeller Foundation.

The Commission has as its chief aim service to the military. It welcomes suggestions for fields of investigation and requests for assistance in the study of viral infectious disease problems of importance, wherever these may occur, in endemic or epidemic circumstances.

This Is Your A. M. A.

NEVER IN HISTORY had the people who produce newspapers, magazines, motion pictures, and television and radio programs had a greater desire for medical information.

The American Medical Association has long been looked upon as the most authoritative source of medical information in the world, and disseminator of this information for the Association is the Communications Division, composed of 8 departments. Two of these, the *AMA News* and *Today's Health* magazine, have previously been discussed; the remaining 6 departments will be explored in this article.

Media Relations Department

Largest of these departments is Media Relations, which comprises separate sections on press, magazines, radio and television, and exhibits.

The Media Relations Department is specifically charged with coordinating all media relations activities of the Association, handling liaison with national organizations representing media, and counseling state and county medical societies on media relations problems.

Among the varied activities of the press relations section are handling requests for assistance from news writers and editors, from newspapers, news magazines, and wire services, planning and executing press operations in over-all promotion campaigns, and carrying out press operations for all meetings sponsored by the Association.

The weekly news release, which is based on original articles appearing in A.M.A. publications, is distributed to 3,000 newspapers, radio and television stations, and free-lance science writers.

Services to national consumer and special-interest periodicals are handled by the magazine relations section. This includes screening all consumer magazines for articles involving medicine or health, reviewing articles for publication in a weekly column in the *Journal of the American Medical Association*, and presenting story ideas to magazine editors and writers.

The section on radio and television is responsible for activities involving broadcasting and film media directed to the general public. This includes planning and preparing motion pictures and transcribed radio programs for use on local stations, assisting television and radio producers, directors, and newsmen in the areas of news, drama, and public affairs programing. The section also supervises operation of A.M.A.'s transcription- and film-booking desks, prepares story ideas on Association activities for submission to network newsrooms and special-event departments, and consults with state and county medical societies on radio and television. Activities of the Physicians Advisory Committee on Television, Radio, and Motion Pictures are coordinated by the section.

The Association's public information program is further carried out by the exhibit section, which counsels other departments in planning and construction of specific exhibits. During the past year, 25 new units were added to the library, including exhibits on aging, health care of the athlete, history of medical education, sunlight and the skin, health appraisal of the school child, and a career in medicine. A major production was the development of a "Transparent Twins"

From the Council on National Security of the American Medical Association. The views and opinions expressed are not necessarily those of the Department of Defense.—EDITOR.

exhibit on the human body. This unit, the only one of its kind in the United States, is used at health fairs throughout the nation.

In the last 12 months, A.M.A. exhibits were shown 343 times in 36 states for a total of 1,571 show days before public meetings, state and county fairs, allied health groups, health fairs, and state medical society meetings.

Medical Motion Pictures and Television Department

This Department plans and directs motion picture programs at the Association's annual and clinical meetings, coordinates medical closed-circuit television programs either sponsored by the A.M.A. or made in cooperation with other organizations. This department also supervises preparation of the scientific film library.

During the past year, the department planned and presented programs for the Second World Conference on Medical Education and the 1959 meeting of the World Medical Association; selected films for showings at the 1959 Edinburgh International Film Festival, and at medical schools in Glasgow and London; assisted in the planning of an international film exhibition at the 1960 meeting of the World Medical Association in Berlin.

Program Development Department

The newest of the Communications Division's departments is that of Program Development, which prepares and directs special projects for the Association. This group initiates literature, speeches, films, exhibits, magazine, and press releases as they relate to specific programs. Most recently this department's major responsibility, in close cooperation with various other A.M.A. units, was the development of an informational and educational program on health care of the aged, which was directed at Congress, the profession, and the public.

The department maintains a continuing program to recruit talented young people into the study of medicine, and has distributed 12,000 career guidanceki ts to state and county societies, medical schools, state guidance supervisors, and 8,000 members of the National Vocational Guidance Association. Program Development also participated for the Association in the National Science Fair and was co-host for 1,000 high school students at a Health Awards banquet.

Special Services Department

Activities involving production of newsletters, literature, and counseling service to state and county medical societies on public relations projects is the responsibility of the Department of Special Services.

In helping component societies to improve their public relations programs this department publishes a bimonthly PR Doctor newsletter, which has a circulation of 5,800 and arranges the annual PR Institute.

The department also assigns and supervises writing, production, and distribution of general A.M.A. literature and of specific materials.

Responsibility for guided tours of the newly remodeled A.M.A. building, which are available to all visitors, is vested with this department.

Services to Officers Department

This Department has the responsibility for developing and preparing speeches, articles, and statements for officers of the Association. Department members

also serve as administrative aides to the president and president-elect, clearing and arranging speaking engagements, and as press aides, helping to set up newspaper, radio, and television interviews and appearances.

American Medical Education Foundation

Recently incorporated into the Communications Division is the American Medical Education Foundation. The nonprofit education foundation was organized to promote the art and science of medicine by providing financial aid to recognized schools of medical education shortly after World War II, when rising costs threatened to jeopardize the future of the profession. Since that time, $9,074,736 has been distributed from funds contributed largely by individual physicians and medical groups.

Navy Surgeon General Honored by Sweden

The Medical Board of the Royal Swedish Armed Forces has presented the crown-crested plaque shown here to Rear Admiral Bartholomew W. Hogan, Surgeon General of the United States Navy, in gratitude for the study tours arranged for Swedish medical officers and the assistance given by numerous American medical officers who have visited Sweden. In 1957, a party headed by Commodore Lars Troell, Surgeon General of the Royal Swedish Navy, devoted two months to observing U.S. Navy medical facilities and organization. In the reverse direction, during 1959–60, more than a dozen of our medical officers have presented papers in Sweden on topics such as "Medical Aspects of Nuclear Submarines," "Studies on Experimental Shigellosis III," "Tissue Bank Operation," and "Problems Associated With Total Body Radiation."

Translation of the legend on the plaque: "Armed Forces Medical Board."

Book Review

MEDICAL DEPARTMENT OF THE UNITED STATES ARMY. SURGERY IN WORLD WAR II. Neurosurgery, Volume II. Editor-in-chief, Col. *John Boyd Coates, Jr.*, MC, USA. Editors for Neurosurgery, *R. Glen Spurling*, M.D., and *Barnes Woodhall*, M.D. Associate editor, *Elizabeth M. McFetridge*, M.A. 705 pages; 283 illustrations, 12 color plates. Historical Unit, Army Medical Service, Office of the Surgeon General, Department of the Army, Washington, D.C., 1959. Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price $7.

Under the leadership of Colonel John Boyd Coates, the Historical Division of the Army Medical Corps has published a number of volumes reporting historically, and analyzing scientifically, medicine and surgery as practiced during the second world war. The student of the two volumes concerned with neurosurgery will obtain an enlightened picture of all phases of military neurosurgery and its progress during the war years. He will find that, out of those years, new concepts and new methods have evolved that will be guides to further development in the years to come. The present volume is concerned with injuries of spinal cord and peripheral nerves. Seven chapters are devoted to injuries of the spinal cord. Evolution of the modern concept of management of paraplegia problems originated in the second world war. The principles on which this concept is based are set forth in instructive detail. Early operative treatment of compound wounds of the spinal canal and its contents became policy. Matson's chapter devoted to the surgical management of the acute compound battle-injured spinal cord gives a concise and instructive picture of the all-important neurologic examination, methods of laminectomy, and immediate postoperative care. The concept of the neurogenic bladder, as it was understood in the second world war, is presented in a chapter by Prather. The information appearing in this particular chapter forms the basis for the progress that has been made in this field after the war. Recognition of the need for a joint effort on the part of neurosurgeons, orthopedists, urologists, internists, and physical therapists brought about attention to minute therapeutic details that proved to be the greatest single factor in reduction of mortality and morbidity, thus leading the way toward the ultimate goal of rehabilitation. To cite only one example, the vital importance of correction of the protein deficits in the presence of paraplegia was first recognized in the second world war. The management of paraplegia, as it evolved in the last years of the second world war, is responsible for the tremendous progress that has been made in this field of endeavor; it is responsible for the fact that the life expectancy of the paraplegic is today essentially the same as that of any man. Part II, dealing with peripheral nerve injuries, consists of 15 chapters and is co-authored by 18 contributors. The striking improvement in peripheral nerve surgery during World War II rested more upon a fuller appreciation of the principles of nerve repair than upon mechanical or surgical advances in technic. The experiences recorded in these chapters, covering all facets of peripheral nerve surgery, make up the most instructive text available today. Methods of examination, anatomic approaches, technic of repair, aspects of combined peripheral nerve-vascular injuries, and problems of causalgia are discussed concisely and instructively. A splendidly illustrated chapter on neuropathologic changes of

injured peripheral nerves adds substantially to the understanding of the over-all problem. The validity of the principle of early nerve repair, with the optimum time between the third and sixth week after injury, is borne out by the experiences in the second world war. Appreciation of the influence of soft tissue, bone, and vascular injuries upon the timing of nerve repair points to the necessity of coordinating the talents and efforts of vascular surgeons, orthopedists, and neurosurgeons in the management of peripheral nerve wounds. An appendix to the book gives valuable short-term follow-up data, obtained by the Peripheral Nerve Registry, which was organized in 1944. In their second volume of the history of military neurosurgery during World War II, Spurling, Woodhall, and their co-authors have provided us with a text of lasting significance that will be a stimulus and a guide to the student and to the teacher of all phases of spinal cord and peripheral nerve injuries.

ARNOLD M. MEIROWSKY, M.D.

New Books

EVERY SERVICEMAN'S LAWYER, by *Earl Snyder*, A.B., LL.B., LL.M. 341 pages. Stackpole Co., formerly Military Service Publishing Co., Harrisburg, Pa., 1960. Price $3.50.

MEANING AND METHODS OF DIAGNOSIS IN CLINICAL PSYCHIATRY, by *Thomas A. Loftus*, M.D. 169 pages. Lea & Febiger, Philadelphia, Pa., 1960. Price $5.00.

PEDIATRICS 1960–61, edited by *Robert A. Lyon*, M.D. Davis Monograph Series. 104 pages; illustrated. F. A. Davis Co., Philadelphia, Pa., 1960. Price $3.50.

TREATMENT OF CARDIOVASCULAR EMERGENCIES, by *Aldo A. Luisada*, M.D., and *Leslie M. Rosa*, M.D. 122 pages. Blakiston Division, McGraw-Hill Book Co., Inc., New York, N.Y., 1960. Price $4.95.

PROCUREMENT AND MATERIALS MANAGEMENT FOR HOSPITALS, by *Rex H. Gregor* and *Harold C. Mickey*, B.B.A., F.A.C.H.A., with a foreword by *Everett W. Jones*. 159 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $7.50.

A STEREOTAXIC ATLAS OF THE DOG'S BRAIN, by *Robert K. S. Lim*, M.B., Ch.B., Ph.D., D.Sc., *Chan-nao Liu*, Ph.D., and *Robert L. Moffitt*, B.S., with a foreword by *William F. Windle*. 93 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $9.25.

THE PRACTICE OF PERIODONTIA (Oral Medicine), by *Sidney Sorrin*, D.D.S., F.A.C.D., F.A.D.M., with the cooperation of the faculty of the department of periodontia and oral medicine, New York University College of Dentistry; Introduction by *Raymond J. Nagle*, A.B., D.M.D., F.A.C.D. 496 pages; illustrated. Blakiston Division, McGraw-Hill Book Co., Inc., New York, N.Y. Price $19.50.

MEDICAL HISTORY TAKING, by *Ian Stevenson*, M.D. 273 pages; illustrated. Paul B. Hoeber, Inc., Medical Division of Harper & Brothers, New York, N.Y., 1960. Price $6.50.

A TEXTBOOK OF HISTOLOGY, Functional Significance of Cells and Intercellular Substances, by *John C. Finerty* and *E. V. Cowdry*. 5th edition. 573 pages; 502 illustrations on 374 figures, 18 in color. Lea & Febiger, Philadelphia, Pa., 1960.

THE OUT-PATIENT TREATMENT OF SCHIZOPHRENIA, A Symposium, edited by *Sam C. Scher* and *Howard R. Davis*. 246 pages. Grune & Stratton, Inc., New York, N.Y., 1960. Price $5.75.

MEDICAL PROBLEMS OF MODERN AIR TRAVEL, by *Harold V. Ellingson*, M.D. Davis Monograph Series. 26 pages. F. A. Davis Co., Philadelphia, Pa., 1960.

CLINICAL APPLICATIONS OF BRONCHOLOGY, by *Dezso Kassay*, M.D. 225 pages; illustrated. Blakiston Division, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

CEREBRAL PALSY AND RELATED DISORDERS, A Developmental Approach to Dysfunction, by *Eric Denhoff*, M.D., and *Isabel Pick Robinault*, Ph.D. 421 pages; illustrated. McGraw-Hill Book Co., Inc., New York, N.Y., 1960. Price $12.00.

CHEMISTRY OF HEART FAILURE, by *William C. Holland*, M.D., and *Richard L. Klein*, Ph.D. 116 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $5.50.

CIBA FOUNDATION SYMPOSIUM ON CELLULAR ASPECTS OF IMMUNITY, edited by *G. E. W. Wolstenholme*, O.B.E., M.A., M.B., M.R.C.P., and *Maeve O'Connor*, B.A. 495 pages; illustrated. Little, Brown & Co., Boston, Mass., 1960. Price $10.50.

THE MANAGEMENT OF THE DOCTOR-PATIENT RELATIONSHIP, by *Richard H. Blum*, Ph.D., with a foreword by *Joseph Sadusk*, M.D., and *Rollen Waterson*. 304 pages. Blakiston Division, McGraw-Hill Book Company, Inc., New York, N.Y., 1960. Price $8.50.

ELEMENTARY INTRODUCTION TO NUCLEAR REACTOR PHYSICS, by *S. E. Liverhant*. 447 pages; illustrated. John Wiley & Sons, Inc., New York, N.Y., 1960. Price $9.75.

FUNDAMENTALS OF NERVE BLOCKING, by *Vincent J. Collins*, M.S., M.D., with the assistance of *Emery Andrew Rovenstine*, M.D. 354 pages; illustrated. Lea & Febiger, Philadelphia, Pa., 1960. Price $9.50.

THE LONG SEARCH FOR THE TRUTH ABOUT CANCER, by *Mark Boesh*. 316 pages. G. P. Putnam's Sons, New York, N.Y., 1960. Price $4.95.

THE ANONYMOUS MYCOBACTERIA IN HUMAN DISEASE, The Sixth Annual Ivan. H Mattson I Memorial Conference of The University of Texas Southwestern Medical School and Dallas Tuberculosis Association, edited by *John S. Chapman*, M.D. 173 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $7.50.

CIRRHOSIS OF THE LIVER, by *Martin Seler Kleckner, Jr.*, A.B., M.S. in Internal Medicine, M.D., with forewords by *J. Arnold Bargen*, M.D., and *Archie H. Baggenstoss*, M.D. 729 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $24.50.

THE DYSLIPIDOSES, by *Raul Fleischmajer*, M.D., with a foreword by *Marion J. Sulzburger*, M.D. 509 pages; illustrated. Charles C Thomas, Publisher, Springfield, Ill., 1960. Price $16.

SYNOPSIS OF PATHOLOGY, by *W. A. D. Anderson*, M.A., M.D., F.A.C.P., F.C.A.P. 5th ed. 876 pages; illustrated. C. V. Mosby Co., St. Louis, Mo., 1960. Price $9.25.

TRANSACTIONS AMERICAN SOCIETY FOR ARTIFICIAL INTERNAL ORGANS, Chicago, Ill., April 10–11, 1960. Vol. VI, edited by *George E. Schreiner*, M.D., and 3 assistants. 380 pages; illustrated. Georgetown University Press, Washington, D.C., 1960. Copies may be ordered from Dr. George E. Schreiner, Department of Medicine, Georgetown University Hospital, Washington 7, D.C. Price $8.

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CORRECTION

In the November 1960 issue of the *Journal*, the roentgenographic plate in the Case for Diagnosis on page 1365 was inadvertently printed upside down.

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